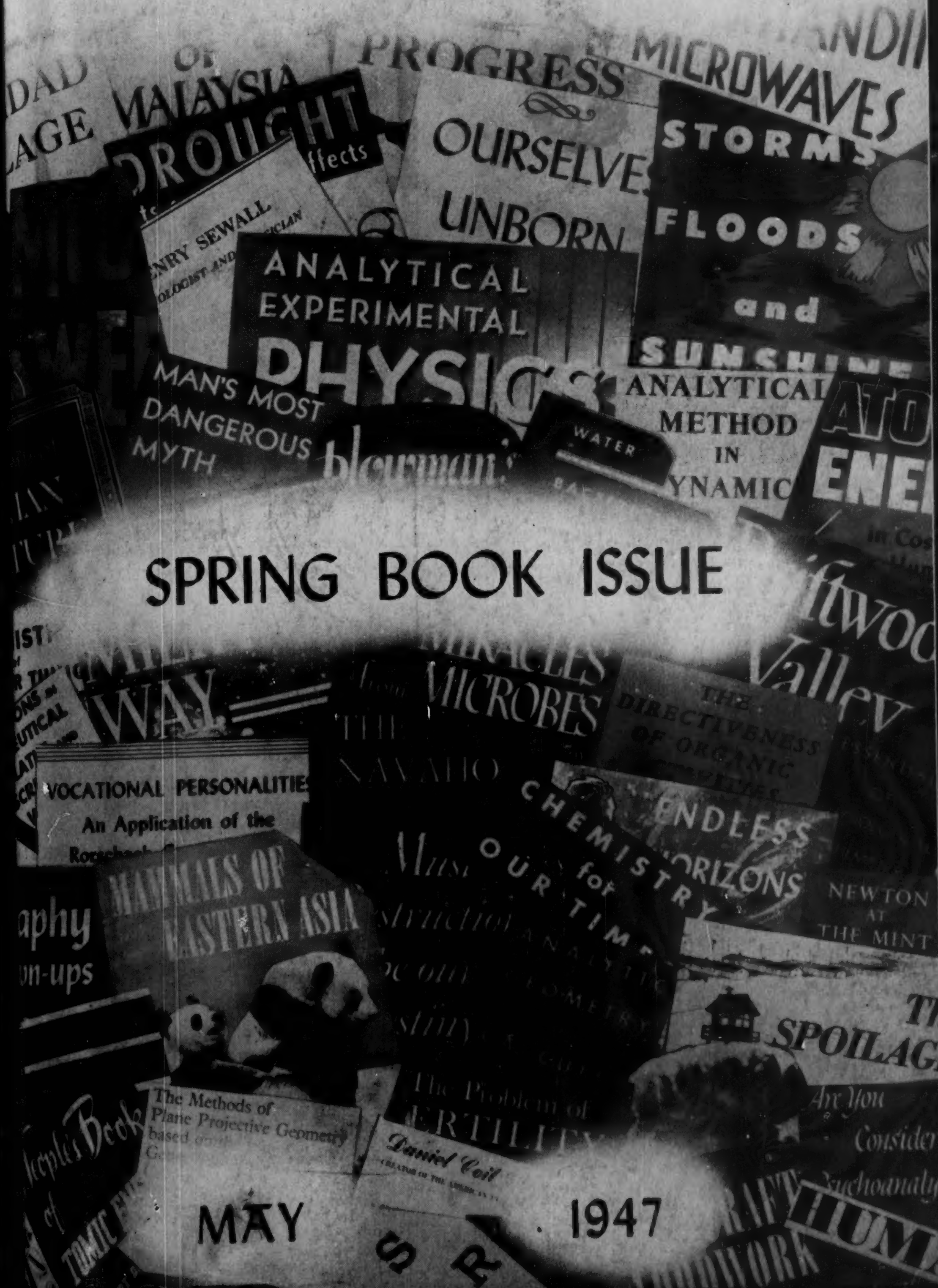
THE SCIENTIFIC MONTHLY



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MEMORIAL LABORATORY, NATIONAL INSTITUTE OF HEALTH

By CHARLES ARMSTRONG

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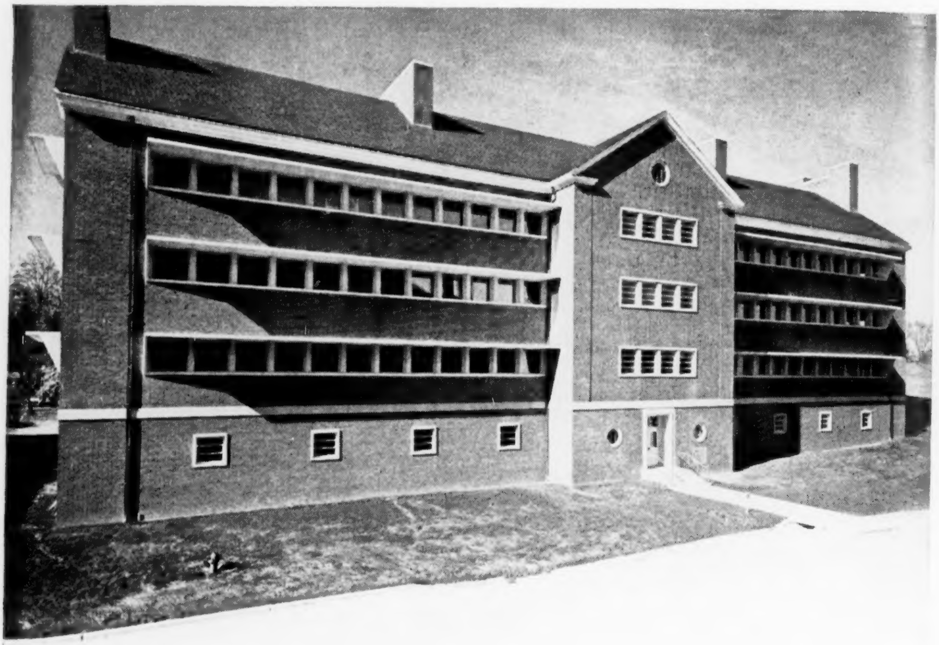
COMPLETE protection of research workers in infectious diseases has long been an unrealized hope of medical science. Each year many valuable men and women contract disease in the course of their work. Most laboratories take certain protective measures, to be sure, or the list of victims would be much larger that it is today. The value of most protective measures, however, has largely depended upon how thoroughly they were observed by the laboratory workers themselves.

The Memorial Laboratory for the study of infectious diseases at the National Institute of Health, formally dedicated on October 27, 1946, is the result of an intensive effort on the part of the United States Public Health Service to provide a safe environment for research personnel. It is designed and equipped to control and contain infections at their source, thereby affording greater protection for every individual in the laboratory.

The need for a specially designed laboratory such as this becomes readily apparent when we review the fifty-nine-year history of the National Institute of Health. At least two of our men have died of laboratory-contracted diseases during each decade. The present one, not yet completed, has already taken four. We have not only lost our friends and co-workers, but medical science has also lost the fruits of their years of experience.

There is another large group of our workers who have contracted diseases in the laboratory but have fortunately recovered. Civil service employees at the Institute enjoy no unusual privileges because of the risks of their employment. Those who have contracted diseases as a result of their work in the laboratory have lost sick and annual leave. If the illness was prolonged beyond their accumulated leave time, they were remunerated under the United States Employees Compensation Act at a lower income rate than they would have received on active duty. Still these people returned faithfully to work under conditions that previously had been a contributing factor to their disability.

Medical science is the loser in other ways, too. At times we have felt that certain projects—vital though they were—should be suspended because of the great danger involved. For instance, while we were working on "Q" fever in 1940, 16 cases of



USPHS Photo

THE NEW MEMORIAL LABORATORY, NATIONAL INSTITUTE OF HEALTH

THIS BUILDING, LOCATED IN BETHESDA, MD., IS UNIQUELY EQUIPPED TO PROTECT RESEARCH WORKERS FROM THE DEADLY EFFECTS OF INFECTIOUS DISEASES THAT WILL BE STUDIED. IT WAS DEDICATED OCTOBER 27, 1946, IN HONOR OF THOSE EMPLOYEES OF THE U.S. PUBLIC HEALTH SERVICE WHO LOST THEIR LIVES IN LINE OF DUTY AFTER HAVING CONTRACTED THE INFECTIOUS DISEASES THEY WERE STUDYING.

the disease suddenly broke out among the men in the laboratory. One died. We then stopped work on this particular disease.

Five years later, after we had DDT'd the building thoroughly to control insects, work on Q fever was resumed. Within less than two months, another outbreak occurred—this time 47 cases. Luckily, there were no fatalities. We now believe the disease is airborne. Our new laboratory is so constructed that it is thought that air currents may be controlled and airborne diseases contained within a small area. This time, research on Q fever will go on.

Previous to this outbreak of Q fever, we were badly shaken by events that occurred in the fall of 1944. Three of our employees died within a period of six weeks. Bacteriologist Rose H. Parrott died from a tularemia infection contracted in her laboratory at the National Institute of Health on September 11, 1944. Eighteen days later, Philip L. Jones, Scientific Aide, died of tsutsugamushi at the Rocky Mountain Spotted Fever Laboratory, Hamilton, Mont. Twenty-two days later, Dr. Richard G. Henderson was fatally infected with the same disease here at Bethesda, Md.

The conclusion was obvious. Something more needed to be done in order to give full protection to our workers.

Dr. Thomas Parran, Surgeon General of the United States Public Health Service, immediately moved to obtain funds for a building especially designed to protect persons engaged in research on infectious diseases. He and Dr. R. E. Dyer, Director of the National Institute of Health, his assistant, Dr. L. F. Badger, and virtually every member of our laboratory staff

contributed something to the final plan. In addition, Dr. Badger and Dr. N. H. Topping made a tour of a number of the new laboratories in the country, searching for ideas related to our problems.

In the main, our concerns were fourfold. First, we wanted to separate research on different diseases. Second, we wanted to control the air flow in and out of every room and working space in the building. Third, we needed heretofore undesigned equipment to protect the worker against infection. Fourth, we needed an easily enforceable set of rules affecting the movements of personnel about the building. We believe that the memorial Laboratory as it now stands provides for the solution of all these problems.

There are six individual research units. Two are located on each of the three floors and are separated by a "clean" (non-contaminated) area housing administrative facilities and personnel. Refuse from each unit is dropped by elevators to incinerators, one at each end of the basement. Separate elevator shafts for each unit preclude any possibility of cross ventilation between laboratories. Refuse cans are sterilized in the basement by steam before being returned for further use.

The air and its flow are under control from the time air enters the building through intakes on the roof until it is drawn off by outlets, also on the roof. Clean areas contain a higher pressure than the contaminated areas so that the drift will always be toward, and not from, the location of infectious materials.

This drift-direction control is the basic concept of our air-conditioning system and is carried out in every room and in every working space. The air enters large perforated ceiling panels at a low velocity, minimizing the possibility of drafts or dust-raising. It is drawn toward the infectious material on the workbenches and is exhausted through a wall slot at the rear of the bench. Circulation is constant and so planned that no contaminated air will be recirculated.

The problem of air control has not only influenced the architectural scheme of the laboratory but has also been a prime consideration in the construction of all the newly designed protective equipment.

Each of the six research units is identically laid out and equipped and may be entered only from a clean area. A double set of doors serves as an air lock between the wings and the central part of the building. Once inside, the worker changes to his distinctive work clothes in a clean dressing room and enters the unit proper. Upon leaving the unit, he reverses the procedure, leaving his work clothes in a contaminated dressing room before donning his other garments in the clean one.

Following the policy of containing the most dangerous threats to health in as small an area as possible, each unit has two laboratories—one slightly smaller than the other—and these in turn are subdivided into special rooms equipped with sterile cubicles and protective cabinets.

The protective cabinets were designed to guard against the spray from high-speed equipment such as tissue grinders or electrical blenders. Safety features in these devices include 30-watt ultraviolet lamps, which sterilize the air in the cabinets, and electric circuits that remain broken unless the entrance window is latched shut, completely enclosing the equipment.

Tissue culture and other bacteriological procedures will be carried on in temperature-controlled sterile cubicles, each about the size of four telephone booths. Incoming air is filtered through spun glass and subjected to ultraviolet irradiation to prevent contamination of the experimental material.

Workbenches are provided with glass hoods that protect the face of the worker

and provide fluorescent illumination, as well as ultraviolet radiation that destroys exposed pathogens. Controls for water, gas, and electricity are installed on the near face of the bench, making it unnecessary to reach over infectious material. An electric grill air exhaust, also present in the protective cabinet and the sterile cubicle, draws the air away from the bench and sterilizes it at temperatures exceeding 500° C. before releasing it through the roof outlet. A can for experimental refuse is inserted into a cutout in the bench. When closed with a tight-fitting cover, it can be safely carried to the autoclave for sterilization before the contents are sent to the incinerator.

Other facilities of each unit include:

1. An autopsy room where infections are transferred and autopsies performed. The workbench here is also equipped with hood and electric grill air exhaust.
2. One constant high room (with a range from 70°F. to 120°F.) and one constant low room (with a range from 10°F. to 60°F.).
3. One large and two small animal rooms with ceiling-hung cage racks. Following the air-drift policy, pressure in these rooms will be lower than that in the rest of the unit to minimize the spread of odors.
4. A storage room, complemented by a much larger one in the basement.
5. A cage washing and sterilizing room containing one large and one small autoclave. The entrance to the elevator shaft is also located here.
6. A water-distillation room equipped with two water stills having a production capacity of 5 liters per hour per machine.
7. A serological laboratory.
8. An office and a library-conference room.

Employees will wear simply designed, white, zippered coveralls in the research units and like garments of blue in the clean areas. Since there is only one exit from the units—through the dressing rooms—there is small possibility that workers will carry infection on their persons.

The new Memorial Laboratory was constructed and equipped at a cost of approximately $1,200,000. Like the seven other buildings at the National Institute of Health, it is constructed of red brick, but its deep-set, triple, thermopane windows and a substantial solar canopy give the new laboratory a rather different appearance.

Research operations will begin in the new structure as soon as the units are completed and fully equipped. One unit will work on Rickettsial diseases—typhus fever, Rocky Mountain spotted fever, Q fever, Rickettsialpox, and the like. Another will be confined to pathogenic molds; a third to psittacosis and related diseases; a fourth to brucellosis; a fifth to poliomyelitis and other central nervous system diseases; and the sixth to the common cold.

Although the last-mentioned is not as dangerously virulent as the others, we believe that the causes of the common cold are perhaps multiple. In this instance, we shall use our protective devices to isolate the material from extraneous infections rather than personnel from the material.

The study of these projects is our program for the immediate future. The schedule is not inflexible, however. As new problems arise in the field of medical research or as old problems gain new significance, we shall shift our attention and our facilities to meet the new need in the shortest possible time.

Whatever the future course of our studies may be, we can now go to work—despite the dangers involved—with a feeling of confidence that we have provided for our people every possible protection within the realm of our present knowledge and experience. We sincerely hope that our honor roll of heroes—to whom this laboratory is dedicated— will not grow longer.

THE ONLY KNOWN FISH-CATCHING PLANT: UTRICULARIA, THE BLADDERWORT

By E. W. GUDGER

The American Museum of Natural History, New York

IN HIS unique monograph *The Carnivorous Plants* (1942), Francis E. Lloyd lists (excluding the carnivorous fungi—*Cordyceps*, *Empusa*, etc.) 6 families, including 15 genera and 515 species, of these plants. Since some of these feed on animals other than insects, Lloyd prefers to call them carnivorous rather than insectivorous plants. Among the noninsectivores are the 275 species of the genus *Utricularia*—most of them aquatics. These Utricularias are of world-wide distribution and are ubiquitous in tropical and temperate regions.

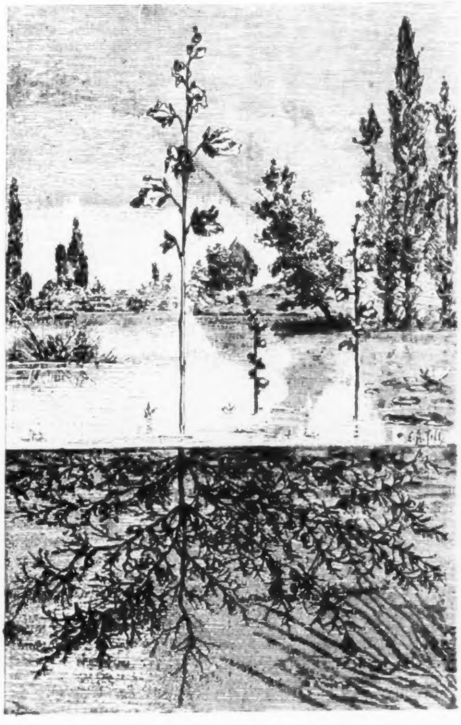
Carnivorous animals capture their prey either by virtue of superior speed or superior cunning. Carnivorous plants, being sedentary, have to wait for their prey to come to them and have developed traps wherewith and wherein to catch their prey. Furthermore, many of them secrete in their traps certain ferments which prepare their catches for digestion. Thus these plants turn the tables on animals, which are directly or indirectly plant-eaters.

Most of these traps are passive—the trap makes no effort or movement to catch the prey. A few kinds have active traps which display special movements in capturing their prey; for example, the "steel trap" of Venus's-flytrap. But the most highly specialized of the carnivorous plants is Utricularia, and its trap is possibly the most elaborate and peculiar of all the traps ever found.

THE FISH-CATCHING PLANT

Most flowering plants are fixed to the earth and restricted to certain food from it—mineral salts dissolved in water—which food they draw up through their roots. The aquatic bladderworts, however, are mostly floating, rootless, annual flowering plants, which at the proper season send up aerial stems with a considerable inflorescence for the production of seeds. Their underwater parts are most interesting. The submersed floating Utricularias of the *vulgaris* type have the widest distribution and are all potential fish-catchers.

The species illustrated in Figure 1 is the commonest and perhaps the most wide-



After Halperine, 1885

FIG 1. *UTRICULARIA VULGARIS*

THIS ROOTLESS, FLOATING BLADDERWORT BEARS AERIAL FLOWERS THAT ARE POLLINATED BY INSECTS. THE BLADDERS APPEAR UNDER WATER.

spread floating form, *Utricularia vulgaris.* As seen in the figure, the underwater parts are the more abundant, branching out loosely over an area several feet in circumference. The most interesting of these underwater parts are the abundant utricles (*L. utriculus,* "a bottle or bladder") which give the genus its name. In these multitudes of bladders, small water dwellers—microscopic plants and animals (unicellular algae, worms, crustaceans, mosquito larvae, infusoria)—and even small fishes are entrapped.

That active fishes, vertebrate animals, even though tiny ones, should be entrapped in the bladders of an aquatic flowering plant is certainly turning normal plant-animal relations topsy-turvy. The fish-destroying habits of the common bladderwort are extraordinary in the *n*th degree and to botanists and students of fish predators of very great interest. Hence it seems well worth while to bring together the relatively few accounts (most of them about 60 years old).

Drawings and photographs of the fish-catching plant, made to illustrate various accounts to follow, are all too small to show with any accuracy the details of its structure. Hence, they will be passed over and for an adequate representation of the plant in its habitat, there will be introduced a photographic reproduction of a part of Dr. Roy W. Miner's splendid pond-bottom group in the Darwin Hall of the American Museum of Natural History. Here a cubic half inch of pond bottom is magnified 100 times.

In Figure 2 is shown part of a pond-bottom jungle with a large Utricularia stalk extending diagonally from lower left to upper right. This stem has numerous bladders attached to what are morphologically leaves. Figure 3 portrays (greatly enlarged) the bladder shown in the center of Figure 2. This contains partly decomposed prey—not fishes, however.

DISCOVERY OF THE FISH-CATCHING HABIT

The bladderwort has long been known to be a carnivorous plant, but by various early students it was thought to catch only microscopic aquatic invertebrate animals—small crustaceans, worms, and insect larvae.

That the bladderworts catch fishes was discovered in the spring of 1884 by G. E. Simms, Jr., of Oxford, England. Immediate publication of his discovery led to the appearance of a number of articles on this fish-catching habit in 1884, 1885, and 1890. Since 1890 almost nothing of value has been published. These accounts will be reviewed as nearly as may be in the order of publication. But since the early ones are by two men with dates overlapping, the contributions of each man will be considered in a group, beginning with those of the discoverer (1884. 1) who, so far as the records go, was the first to witness the curious phenomenon under study. Though he was a resident of Oxford, he apparently was not a student at the university. However, he carried his material and his problem to Professor H. N. Moseley in the museum of the university. Moseley became greatly interested and advised him how to deal with his discovery.

Simms's first article was published in the *Fishing Gazette* of May 31, 1884. To this I have not had access, but fortunately it and other early articles on Utricularia did not escape the eye of Professor Spencer F. Baird or of his assistants in the U. S. Fish Commission. This and other early accounts of fish-catching by Utricularia were republished (presumably verbatim) in the Bulletin of the Commission for July 30, 1884. Since Simms's account is the basis for everything that follows in this article, and since in it he has put everything very clearly, it seems best to follow him closely and to quote him extensively. In reading his account, constant reference should be made to the illustrations.

Simms's materials were collected not from active streams but from "still ponds and deep ditches," quiet waters in which Utricularia "is most likely to work mischief to young fry" of fishes. Of the action of this plant he writes as follows:

I have recently discovered amongst the aquatic weeds placed in my aquarium, where I have also a large number of newly-hatched perch and roach, a novel and unexpected enemy to the pisciculturist in the bladder traps of *Utricularia vulgaris*, which is capable of catching and killing young fry.

My attention was first drawn to it by observing

FIG. 2. A POND-BOTTOM JUNGLE SHOWING BLADDER-TRAPS

A PHOTOGRAPH OF ROY W. MINER'S POND LIFE GROUP IN THE AMERICAN MUSEUM OF NATURAL HISTORY.

that several of the tiny fish, without any apparent cause, were lying dead on the weeds, while the rest of the brood looked perfectly healthy and in good condition. At first I was somewhat puzzled at the strange position in which they were lying, and in trying to move one with a small twig I was still more surprised to find it was held fast by the head, in what I thought, when I pulled the plant from the water, were the seed vessels; and a still closer examination revealed the strange fact that others of the little fish had been trapped by the tail, and in one or two instances the head and tail of the same fish had been swallowed by adjacent bladders, thus forming with its body a connecting bar between the two.

At first I was undecided how to act, for I could

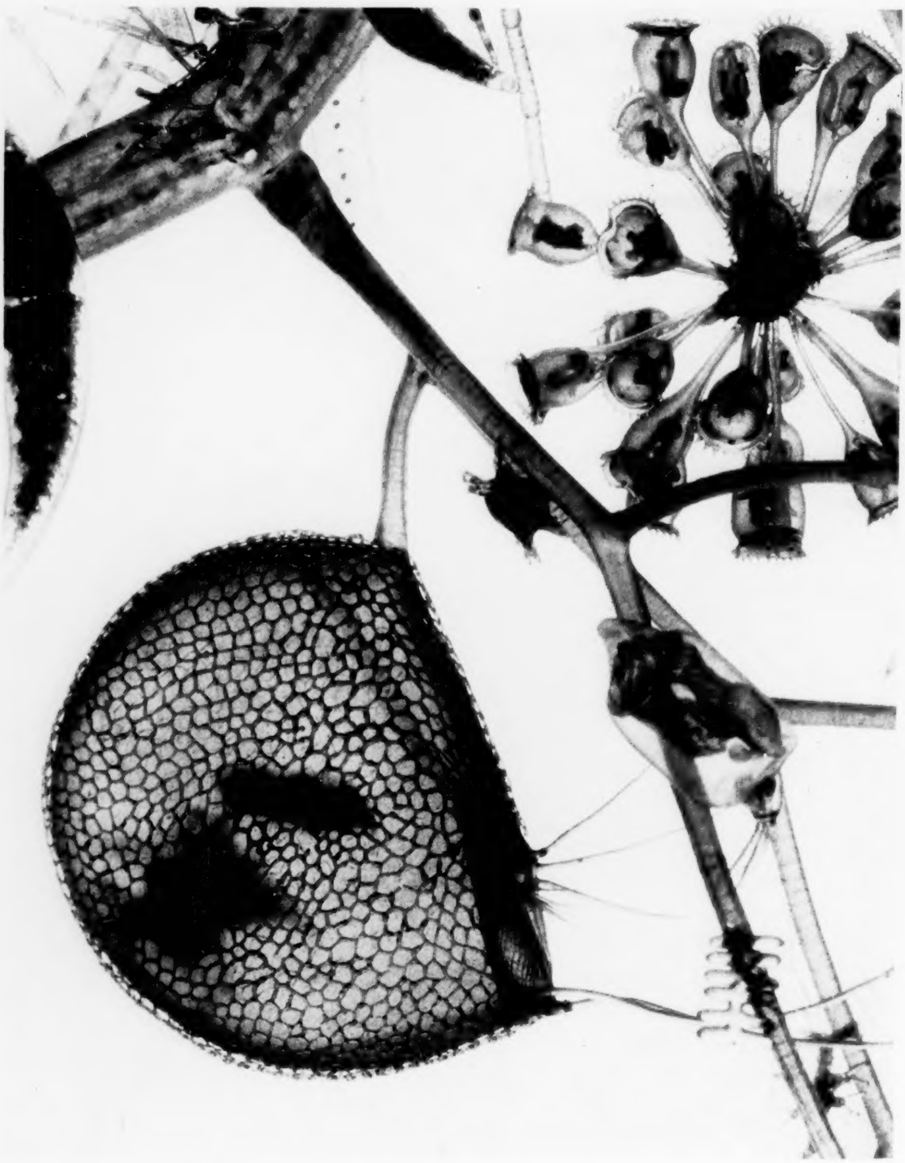


FIG. 3. A MAGNIFIED BLADDER-TRAP OF *UTRICULARIA VULGARIS*

DETAIL FROM THE CENTER OF THE GROUP SHOWN IN FIGURE 2. THIS BLADDER DOES NOT CONTAIN FISH.

bring to memory no instance in which I had seen the existence of a piscivorous plant—i.e., one preying on vertebrates—recorded in any book I had ever read, and I was unwilling to make such an assertion without the opinion of some one better capable of forming a judgment on the subject than myself; so I placed one or two good specimens in a glass jar and went to the Museum, where I was fortunate enough to see Professor Moseley, who immediately verified my suspicions.

Moseley brought out a copy of Bentham's *British Flowering Plants* and showed Simms that his plant was the bladderwort, *Utricularia vulgaris.* With help from this work and Darwin's *Insectivorous Plants*, Simms sets forth his observations in the proper botanical setting as follows:

A peculiar fact in connection with it [this plant] is that it has no roots at any time of its life, and the floating, root-like branches, which are covered with numerous capillary and much divided leaves, are interspersed with tiny green vesicles, which were supposed by a former school of botanists to be filled with water, by which means the plant was kept at the bottom until the time of flowering, when the water gave place to air, and the plant then rose to the surface to allow its bloom to expand.

As a matter of fact, these vesicles exercised no such function, their real work being to entrap minute crustaceans, worms, larvae, etc., for its support, and without a good supply of which it is impossible to keep it alive in an aquarium.

Their form is that of a flattened ovoid sac, or, in other words, when seen under a low-power microscope, they are precisely like a human stomach, and they are attached at their hinder extremities each by a very short and fine pedicle or foot-stalk in the axil of the leaves.

Each, too, has an opening at the opposite free extremity, somewhat quadrangular in outline, from either side of which project two branched processes, called by Mr. Darwin antennae. . . .

On either side of the quadrangular entrance several long bristles project outwards, and these bristles, together with the branches of the antennae, form a sort of hollow cone surrounding the entrance, and there cannot be the slightest doubt that they act as a guide for the prey.

The entrance is closed by a valve, which, being attached above, slopes into the cavity of the bladder, and is attached to it on all sides except at its posterior or lower margin, which is free, and forms one side of the slit-like opening leading into the bladder. . . .The valve is colorless and transparent, and is extremely flexible and elastic.

Animals enter the bladders by bending inwards the posterior [or lower] free edge of the valve, which from being highly elastic, shuts again immediately.

The edge is extremely thin and fits closely against the edge of the collar, both projecting into the bladder, and it is extremely difficult, if not impossible, for any animal to escape, although I have observed a long worm do so at the expense of a part of its body; yet, as a rule, it is a case of "all who enter here lose hope.". . .

When a fish is caught, the head is usually pushed as far into the bladder as possible till the snout touches the hinder wall. The two black eyes of the fish then show out conspicuously through the wall of the bladder.

So far as is known, there is no digestive process in Utricularia; neither is there any sensibility to irritation. Mr. Darwin was unable to detect either, his opinion being that whatever nutriment the plant obtained from its prey was by absorption of the decaying matter, and it would appear that the longer of the two pairs of projections composing the quadrifid processes by which the vesicles are lined, which project obliquely inwards and towards the end of the bladder, acts, together with the spring valves at the mouth of the bladder, in utilizing each fresh struggle of the captive for the purpose of pushing it further inwards. . . .

Of its destructive powers all I can say is, that out of 150 newly-hatched perch [roach?] placed in a glass vessel only one or two were alive two days subsequently, and I hope in a few days to be in a position to speak of its powers in nature.

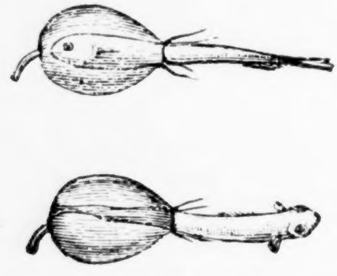
Unfortunately Simms did not publish any figures to illustrate his observations. This is probably due to the fact that just at this time he became ill. Such figures are, however, to be found in his second paper (1884.2).

Simms unfortunately does not give the date when his first observations were made. Probably he saw the fish-catching early in May since he first published May 31, 1884. But shortly after publication of his first report (1884.1), he was probably advised that he should also publish an account in a scientific journal. This was evidently delayed by his illness and it was not until July 24, 1884, that an article by him appeared in *Nature*. This contains little

matter additional to his first article, and it is not necessary to do more than call attention to various particulars therein.

He notes that, while many plants prey on various invertebrates, his discovery of the fish-catching habits of an aquatic Utricularia made known for the first time that such a plant entraps the young of a vertebrate animal. However, this might have been expected of the bladderwort since it catches various water-dwelling invertebrates, crustacea, worms, etc. Then, since Utricularia grows in quiet shady ditches and ponds where "coarse fish" lay their eggs, this baby fish-catching might be expected there. Experiment shows that the plant does not do well unless well shaded.

Simms's second paper (1884.2) is illustrated by a figure of the underwater part of the plant. This is not nearly so good as that shown in Figure 1 and will be omitted. But he does have two figures of little fishes caught by bladders—one by the head and the other by the tail. These (Fig. 4) are the first-known portrayals of this extraordinary phenomenon.



After Simms, 1884

FIG. 4. FISHES CAUGHT BY BLADDERS

THESE EARLIEST FIGURES OF THE PHENOMENON SHOW TWO FISHES CAPTURED BY HEAD AND TAIL.

OTHER CONTEMPORARY ACCOUNTS

Simms had hoped to publish other observations on this fish-catching phenomenon. Probably his illness and the appearance of a short article by Moseley made this superfluous.

One week after Simms showed his plant and captured fishlets to Moseley, and one week before Simms's account appeared in the *Fishing Gazette*, Moseley anticipated him by publishing in *Nature* (May 22, 1884) a short article entitled "A Carnivorous Plant Preying on Vertebrata." This account was also republished verbatim in the Bulletin of the U. S. Fish Commission for July 30, 1884. Moseley states that his article in *Nature* was published with Simms's permission. But, to say the least, it is unfortunate that Moseley did not delay his article a few days until Simms, the discoverer, could publish first and have absolute priority.

Moseley refers (1884.1) to Simms's "find" as follows:

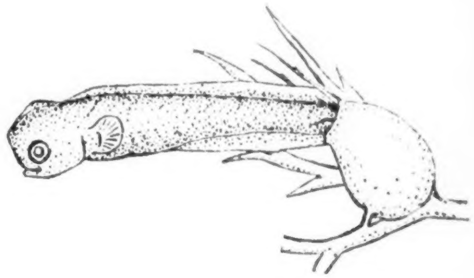
> An interesting discovery has been made during the last week by Mr. G. E. Simms of Oxford. It is that the bladder-traps of *Utricularia vulgaris* are capable of catching newly-hatched fish and killing them. Mr. Simms brought to me for examination a specimen of Utricularia in a glass vessel, in which were numerous young roach newly hatched from a mass of spawn lying at the bottom. Numbers of these young fish were seen dead, held fast in the jaws of the bladder-traps of the plant. . . . Mr. Simms supplied me with a fresh specimen of Utricularia in a vessel with fresh young fish and spawn, and, in about six hours, more than a dozen of the fish were found entrapped. Most are caught by the head, and when this is the case the head is usually pushed as far into the bladder as possible till the snout touches its hinder wall. The two dark black eyes [sic] of the fish then show out conspicuously through the wall of the bladder. Rarely a specimen is seen caught only by the tip of the snout. By no means a few of the fish are, however, captured by the tail, which is swallowed, so to speak, to a greater or less distance, and I have one specimen in which the fish is caught by the yolk-sac. Three or four instances were observed in which a fish had its head swallowed by one bladder-trap and its tail by another adjacent one, the body of the fish forming a connecting bar between the two bladders.
>
> I have not been able to see a fish in the actual process of being trapped, nor to find one recently caught, and showing by motion of the forepart of its body signs of life. All those trapped were found already dead, but I have had no opportunity of prolonged observation.

It was not clear to Moseley just how a little fish is so fully swallowed, but he thought that the "quadrifid processes" lining the bladder and projecting "inwards and towards the posterior end of the bladder" had something to do with it. They and the spring valve of the bladder must work together to this end. However, on cutting open bladders which had caught fish, he found these latter badly decomposed but without any suggestion of digestion. In this he corroborated Darwin's finding. And Simms in his article of May 31, 1884, distinctly says that, so far as he could ascertain, there was no digestion of the fish by the plant.

On June 20, 1884, Moseley dispatched a letter and some specimens in preservative to Professor S. F. Baird, U. S. Commissioner of Fish and Fisheries. Baird had some of the Utricularia material drawn under the direction of John A. Ryder. On July 30, 1884, Moseley's letter was published under the title "The Fish-eating Plant Utricularia or Bladderwort," and the drawings referred to appeared as a plate. He nowhere calls the bladderwort a fisheater in this letter, nor in that copied from *Nature*, May 22, 1884, published just ahead of the present letter. The editor of the Bulletin made a bad slip in his title—"The Fish-eating Plant, Utricularia or Bladderwort."

The figures drawn under Ryder's supervision are four. One showing a young fish caught by the tail in a bladder is reproduced as Figure 5. Note the great disparity in size between the fish and the bladder.

Moseley in his letter to Baird stated that he had not been able to make any observations additional to those already published since the supply of the particular fishlets that get caught had been reduced to nil and since his few bladderworts had seemingly become inert. However, Moseley also stated that he intended to bring specimens and to make a report on this phenomenon at the meeting of the British Association for the Advancement of Science at Montreal later in the year. The Report for the Montreal meeting reveals that Moseley spoke before Section D (Biology) on August 28, 1884. The published abstract (1885) contains nothing not noted above.



After Ryder for Moseley, 1884

FIG. 5. ANOTHER FISH CAUGHT

In the July 11 issue of *La Nature* (Paris, 1885) appeared "Plantes Piscivores," by E. Halperine. This was translated and republished in the Bulletin of the U. S. Fish Commission for August 21, 1885. The writer is an enigma. None of the biographical dictionaries at hand contain his name.

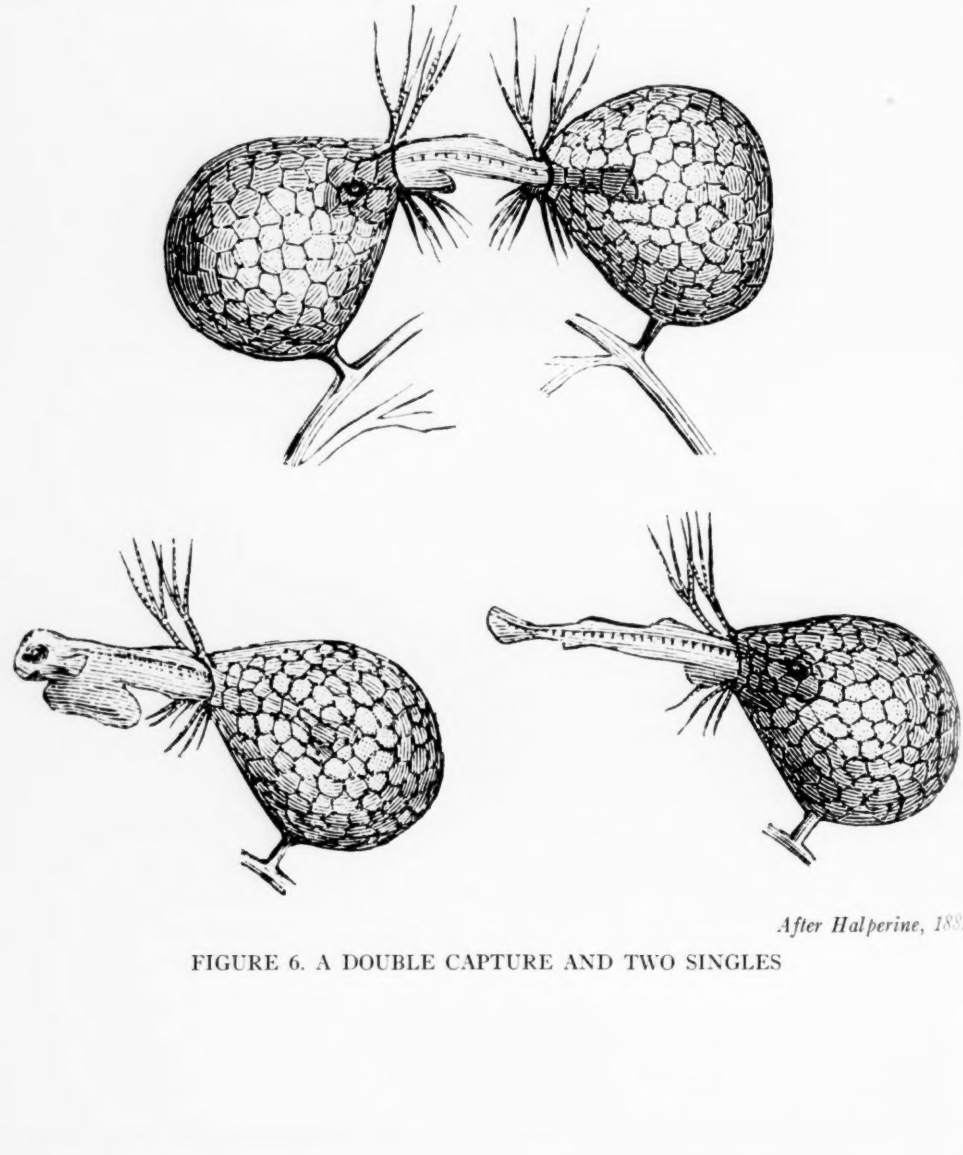
In this article there are various footnote references to writers on "Plantes Insectivores," and there is a brief reference to the observations of Simms and Moseley, but no citations to their publications. It seems probable that this writer knew Utricularia at firsthand. The figure of the plant at the flowering season is the best yet found (Fig. 1). The second figure shows three larval fishes, still in the yolk-sac stage, caught in the bladders—No. 1 by the head, No. 2 by the tail, No. 3 with the head caught by one bladder and the tail by another (Fig. 6). Attention is called to the relative sizes of fishlets and bladders. These are by far the best figures yet found of trapped fishes.

The last of Halperine's drawings shows a small fish completely swallowed and curled

up in the interior of a bladder (Fig. 7). As heretofore attention is called to the relative sizes of fish and bladder. It should be expressly noted that no other student of this plant-fish phenomenon has alleged a complete swallowing of a fish, though there is no reason why a very tiny one could not be so engulfed.

There is nothing to tell us whether author and artist knew the plant and its fish-catching at firsthand, whether their drawings are based on Simms's figure, or whether they are drawn *de novo*. They are different from Simms's figure and are much better drawn. There are no captions. These figures are certainly authentic for the phenomenon and are reproduced for what they show.

Dr. Bashford Dean published in 1890 his second scientific paper and his first one having to do with fishes. It is entitled "Report on the Supposed Fish-eating Plant [Utricularia]." He knew of the studies of Simms and of Moseley and was incited by them to make personal investigations. He studied his plants not as specimens kept in aquaria, but as fresh material from plentiful supplies found in the ponds around the laboratory and hatchery at Cold Spring Harbor, Long Island, N. Y. He spent much time during the months of July, August, and September 1889 in studying



After Halperine, 1885

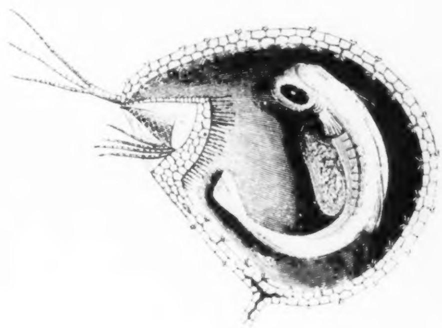
FIGURE 6. A DOUBLE CAPTURE AND TWO SINGLES

the contents of the bladders and must have opened scores, if not hundreds, of these. He is the first and, so far as I know, the only investigator to analyze and to give percentage records of the organisms found in the utricles.

He found that remains of plants, (diatoms, desmids, and the zygospores and oospores of filamentous algae) made up 87 percent of the food remains; animals, living and dead (crustaceans, worms, rotifers, paramecia, tardigrades, etc.), made up the remaining 13 percent. He experimented by giving the bladders living minute crustaceans and found that they were readily taken, that many of them would live for some time in the bladders, and that, when they died, decomposition took place very slowly. Dean judged that "the plant, therefore, possesses no pawpaw-like ferment."

From this mass of evidence, Dean concluded that while the bladderwort catches minute animals, it cannot be considered as very destructive to the young fishes of the pisciculturist since he found no fishes caught in the bladders of his wild plants. However, he concedes that in aquaria with minute fishes and plants crowded together many captures might result. Thus he explained Moseley's observation that nearly all the little fish in a small aquarium were caught and killed. However, in the open, where carp and related coarse fishes may deposit their spawn on aquatic plants, including bladderworts, the hatched fishlets when very small and encumbered with their yolk sacs might be caught if with head or tail they touched and sprung the valves of the bladders. These captures in the open, Dean thought, would be relatively infrequent. At this point he quotes a letter from Professor Minot, of Harvard, that he had found captures by Utricularia "exceedingly rare."

The figures which Dean drew in natural size are reproduced in natural size as Figure



After Halperine, 1885

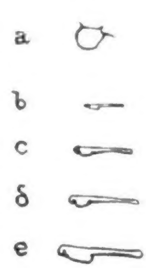
FIG. 7. A FISH ENGULFED

NO SUCH SWALLOWING, HOWEVER, HAS BEEN REPORTED OR FIGURED BY ANY OTHER OBSERVER.

8 and are especially valuable. The bladder, *a*, is 3.5 mm. ($\frac{9}{64}$ in.) long—outside measurement. The opening of the mouth (at top in the vestibule) is 2+ mm. (*c.* $\frac{3}{32}$ in.) wide. Of the fishes shown in actual size at hatching: *b* is a goldfish 5.5 mm. ($\frac{13}{64}$ in.) long; *c* is a carp 8 mm. ($\frac{5}{16}$ in.) long; *d* is a black bass 9 mm. ($\frac{6}{16}$ in.) long; and *e* is a brook trout 11 mm. ($\frac{7}{16}$ in.) long.

After studying the drawing of the bladder and its mouth and these figures of the fishes and contrasting the relative sizes of all, it seems well to quote Dean's own words (p. 191) regarding the capture of fishes by the bladders:

> The entrapment of newly hatched fish is... abnormal, and appears to occur only when the fish



After Dean, 1890

FIG. 8. RELATIVE SIZES

NATURAL SIZE OF A BLADDER AND FOUR NEWLY HATCHED FISHLETS. OF THESE *b* IS A GOLDFISH; *c*, A CARP, *d*, A BLACK BASS; *e*, A BROOK TROUT.

at time of hatching are exceedingly minute. . . . It seems that only during the first few days after hatching the young fish may be secured, since it is then that the fish resting near the bladders, rendered helpless by the yolk-sac, may by a sudden movement find its way to the valve.

In these natural-size portrayals and in his own words just quoted, Dean has given a criterion for studying certain captures previously reported or to follow. It should be noted that he states that the utricles of *A. vulgaris,* which he studied, are among the largest known.

To complete the record, there will now briefly be noted various incidental accounts of reported catchings of fishlets by Utricularia.

Walter in 1894 discussed at length the capture by Utricularia of many forms of fish food, and then gave the following personal observation:

On finding Utricularia, I made an investigation with young 14-day old carp, which were fished out of a breeding pond. In the evening I put a number of these carp fry in a cylindrical vessel 22 cm. high and 14 cm. [about 5.6 in.] in diameter with ten small pieces of Utricularia of about 15 cm. in length, which only covered the space on the surface. The next morning, I was astounded to see that about ten fish had been captured by the bladders.

This account leaves much to be desired. If Walter had been as meticulous in describing the size and activity of these "14-day old" carplings and in stating whether or not the yolk sac had been absorbed, as he was in giving the unessential dimensions of the jar in which they and the plant were contained, his account would have much more value. Furthermore, how did he know that the fishes were fourteen days old? Dean's figure of a baby carp (8 *c*) in natural size at the time of hatching is 8 mm. long. A fourteen-day old carp (i.e., 14 days after hatching) must be at least twice as long (16 mm., $\frac{10}{16}$ in.), or three times larger, and proportionately bulkier. How then could a bladder 3 mm.–5 mm. long have caught and held so large a fish?

Walter in 1899 published a book dealing with the enemies of baby fishes. After discussing the normal food of Utricularia he states:

Small carp fry are caught by the bladders, and indeed either by the head or by the tail, and as Fig. 2*b* shows are held fast until they disintegrate. Trout fry because of their size have nothing to fear from the bladders, but the latter can be damaging to carp fry, even though these soon outgrow the power of the enemy to harm them.

Walter's Figure 2*b* is evidently the product of the unrestrained imagination of the artist. As drawn the bladder is about 23 mm. long. The fish has the tail curled around *outside* the bladder from front to back. Using a thread to follow the curve of the fish's body, I find that in this drawing the fish is about 85 mm. long. It should be noted that the end of the fish's body as drawn is shaded into the drawing of the bladder. Hence it is impossible to get the full length of the fish. Because of its size this fish surely had "nothing to fear from the bladder."

E. E. Green, of Ceylon (no locality noted), sent a letter to the Quekett Microscopical Club (read February 20, 1903) in which he stated:

I have had no experience of the English species of *Utricularia;* but it may be of interest to note that a small aquatic species of the plant in Ceylon can catch and hold young fish in the way described. I have had experience of this fact in my own aquarium, in which I had a species of Utricularia bearing bladders scarce one-sixteenth of an inch in longest diameter. On several occasions I observed young fish (about one inch in length) caught and firmly held by their tails in these little traps [of the size of a pin head].

This statement raises a grave question: Can a bladder one-sixteenth of an inch long hold by the tail an active fish sixteen times its length? Here again we must go to Dean's figures of a bladder and certain just

hatched fishes shown in natural size. Here (Fig. 8*a*) are seen in natural size a bladder ($\frac{4}{64}$ in. long) and a little fish (*e*, a brook trout at hatching, $\frac{7}{16}$ in. long). From this can be judged the difficulty a bladder one-sixteenth of an inch long would have in holding an active fish sixteen times as large as itself. Surely the author must have overestimated the length of his fish.

In J. E. Harting's *Recreations of a Naturalist* (1906) there is a chapter "Fishes Trapped by Bladderworts." This consists of very brief notes of the work of Simms, Moseley, Darwin, and Green. Nothing not contained above is found in it, but this paragraph is added here for the sake of completeness.

Theodore Delachaux published an article —"Fischfressende Pflanzen"—in 1894. No copy of the issue of the journal can be found in the United States. However, one could hardly expect to find much in this one-page article by this fish-culture writer.

Alfred Carpenter had in *Nature* (1884) an article entitled "A Carnivorous Plant." This is but a few pages away from Moseley's account (1884.1) and from Simms's second article. As will be seen below, Carpenter had chanced on something new, and, because his title has got in the bibliographies and will be associated (wrongly) with the bladderwort, it calls for presentation and comment. Carpenter states:

> With reference to Prof. Moseley's letter in your issue of May 22 [1884] (p. 81) on "A Carnivorous Plant Preying on Vertebrata," I may mention that in 1881, when surveying at the Paracel Islands in South China Sea, I saw a somewhat similar occurrence. The tide was low on the reef on which I was strolling and admiring the lovely forms of coral existence. As I neared a pool cut off by the [low ?] tide from the sea, I noticed amongst other submarine verdure a very ordinary-looking flesh-coloured weed about one foot high and of similar girth. My appearance alarmed numbers of tiny fish, which darted to the cover of overhanging ledges, but I noticed about half a dozen apparently seeking cover in the weed. Bending down closer, I saw that they were lying helpless about the fronds, with very little life left in them. Putting my hand down to pick up one of the half-dead fish, I found my fingers sucked by the weed, the fronds of which closed slightly on them. The fish were not caught by the head especially, but held anywhere round the body. The death seemed to be slow and lingering, and where the fish had been held its skin was macerated. These captives may have been caught some time, and were in different stages of exhaustion. I regret being unable to name the plant, or the young fish. They were from an inch to an inch and a half long. The plant had a dirty and rather slimy look about it.

The explanation is not easy. This, in my judgment, was not a plant—no marine plant given to this habit is on record so far as I can find. There are, however, certain noxious plantlike marine animals, colonial hydroids, one of which might be guilty. There are colonial hydroids which to the nonzoological and uncritical eye might without difficulty be thought to be marine plants. Here are some things that further the idea that this "plant" was a hydroid. The fishes "were lying helpless about the fronds. . . were not caught by the head especially but held anywhere round the body." Then when Carpenter attempted to pick up one of the dying fishes, his "fingers [were] sucked by the weed, the fronds of which closed slightly on them." In other words, his fingers were stung by the lasso cells, and by them the "fronds" were drawn toward his hand. Furthermore, the maceration of fish- and fingerskin was probably due to the poison given off from the lasso cells. Moreover, it is well known that colonial hydroids catch and eat fishes.

It is also alleged that Utricularia catches tadpoles. These and other small embryonic amphibians, the fish stage of these animals, are found in the same shady, still waters where the young of the "coarse" fish noted are found, and where Utricularia is likely to abound. However, their alleged captures are only incidentally noted here. That the tiniest forms might be caught by large bladders is conceivable. The trap might possibly catch a very small tadpole by the

tip of the tail. But that it could catch by the blunt nose or by the tail tip and hold a large tadpole seems impossible.

Various persons have referred to this tadpole-catching, but most of their notices are merely incidental. However, W. Bath (1905) has written specifically on tadpole-catching, with illustrations. These show large tadpoles caught by bladders.

In the drawing of the smaller pair, the bladder is about 30 mm. long by 20 mm. deep, and the head of the tadpole (caught by its blunt nose in the mouth of the bladder) is 15 mm. long by 12 mm. deep. In the larger pair, the tadpole is held by the tail. Here the utricle is 43 mm. long by 32 mm. deep, and the head of the tadpole is 22 mm. long by 15 mm. deep. Comparing these drawings with Dean's, one finds it hard to believe that such large, heavy, and powerful animals could be held by the small bladders. Either author or artist would seem to be in error with regard to sizes. Further consideration of this phenomenon must be left to another student.

LE PROBLÈME DE L'UTRICULAIRE

Brocher (1911) coined the phrase, *Le Problème De l'Utriculaire*, and a problem it is. It must be attacked from two angles. First, we must get some clear idea of the structure of the trap and its valve and then we must learn how they work. But first of all it must be understood that the valve of the bladderwort is not a mere check valve, like that in the veins of a man, as was thought as late as 1911. It is probably the most complicated structure known in a plant.

Of this Lloyd says (1942, p. 243) that "it may well be said that the study of the anatomy of the trap is by no means easy." And he demonstrates this by devoting his pages 234–243 to a masterly summary of the work of his predecessors in this study to show the progressive development of our knowledge of this most highly specialized mechanism. Then he presents the results of his own researches in 25 pages. These are illustrated by many plates of photographs and line drawings—all originals. The photographs are so heavily opaque and the line drawings so lacking in lettering and explanations that I can get little from them. However, after many days of study, the essential structures of the trap and their action in the capture of fishes have become well enough understood for them to be briefly presented. In this I have been much helped by reading Skutch's scholarly paper and the other articles listed in the bibliography.

Lloyd (1942, p. 233) gives a good description of a bladder as a trap but has no good figure of the trap as a part of the plant. Fortunately, however, Skutch (1929, pl. to face p. 263) gives a splendid portrayal of a trap of *U. vulgaris* with the door of the valve facing the reader (Fig. 9). Done in wash with no attempt to show the cellular structure of the bladder, it is focused on the door, or valve. Lloyd expressly says that none of his figures are copies. Had he introduced into his description of the trap Skutch's figure (as I have done), his description would have been much clearer. Here follows Lloyd (p. 233):

> The vulgaris type of trap is a small flattened pear-shaped hollow body attached to the plant by means of a stalk placed laterally, and truncated obliquely across the narrow end, where occurs the mouth of [sic] entrance. The stalk side is ventral, the opposite dorsal. The [dorsal] edge of the mouth carries in most cases a pair of branched antennae, and at the sides some slender elongated bristles. These form a sort of funnel ["drift fence," p. 245] leading to the entrance, [presumably] acting as guides for prey. . . .Because of the flattened shape we may speak of the sides and the edge of the trap. The sides may be convex or concave. . . according to physiological circumstances. When the trap is set, they are concave; after action they are less so, and the trap has now a more rounded form.

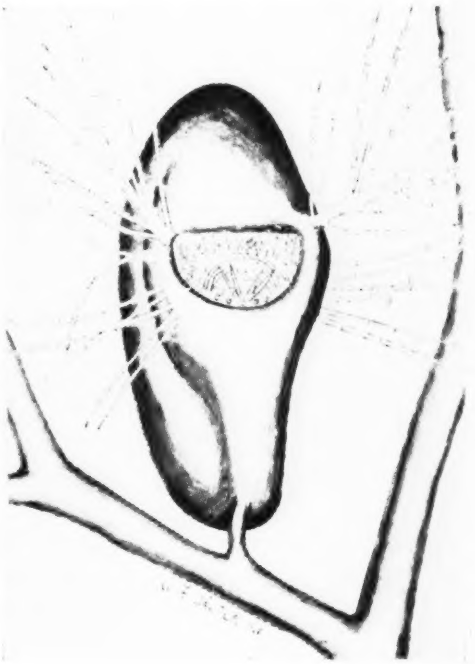
It is important to record just here that

the wall of the trap is everywhere two cells in thickness—except the threshold, or sill (of the door), just under the lower, or free, edge of the valve where the threshold is a massive structure several cells in thickness (Fig. 7). The cells, both outer and inner, of the body wall (with exceptions to be noted later) are covered with a cuticle on their exposed surface which makes the bladder practically waterproof outside and watertight inside.

A utricle must have a stopper; hence the stopper, the door, or valve (two layers of cells in thickness), leading into the bottle is of prime interest just here (Fig. 9). It is the most highly specialized part of this most specialized of carnivorous plant traps. That part of Lloyd's description which applies to the mechanism for the catching of water animals follows:

> The door is attached to the trap along a semicircular line on the dorsal part of the entrance, its free edge hanging and in contact [below] with a firm semicircular collar or threshold against which the door edge rests. The convex outer surface of the door bears a lot of larger or shorter mucilage glands. . . .In addition it bears four stiff, tapering bristles [set in pairs] based near the free, lower door edge. These are the tripping mechanism.

These outer things may be seen in Skutch's drawing (Fig. 9). Notice that the valve is set back within the "mouth," or entrance, leaving a shallow vestibule outside. It is hinged to the wall of the trap across and behind the flattish top of the vestibule and then down each side for a total of about two-thirds of the circuit of the "mouth." At the bottom (along the thickened threshold, and for a short distance up each side) it is free. When this free edge swings inward, it permits the entrance of water and foreign bodies, as we shall shortly see. The face of the valve, as the observer sees it, is convex. The upper part is beset with glandular hairs. I find no explanation for the semicircular lines which are situated in a flat, ring-shaped arch



After Skutch, 1928

FIG. 9. FRONT VIEW OF BLADDER

SHOWING VALVE SET BACK IN THE VESTIBULE; HAIR-GLANDS ABOVE; TRIGGER HAIRS BELOW

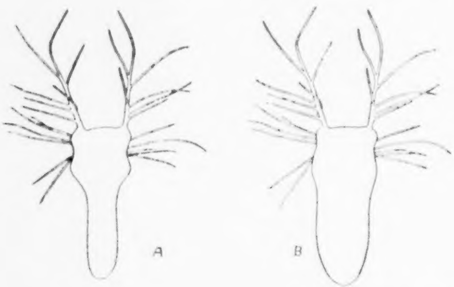
just above the trigger hairs. In this thin and easily flexed region the bending of the valve probably takes place when it swings inward.

Of particular importance are the four bristles (arranged in pairs) at the lower, or ventral, edge of the valve. When these are touched they mechanically lift that portion of the valve, which is tightly pressed against the inner bottom part of the door sill, to form a semicircular opening and permit the influx of water and small organisms (Fig. 7).

HOW THE TRAP OPERATES

Like any other trap, in its functions the bladder of Utricularia exists in two stages or conditions—as the set and the discharged, or sprung, trap. When the trap is in the set stage, the trigger hairs are in position and the valve closed. The elastic sides of the utricle are flattened or pressed inward

(dimpled). This results from the fact that the bladder is largely free of water and is subjected to the hydrostatic pressure of the outside water. The gun is, so to speak, loaded and cocked. This condition is portrayed in Figure 10*A*, showing the bladder in rear aspect. The trap is now set.



After Skutch, 1928

FIG. 10. THE TRAP BEFORE AND AFTER

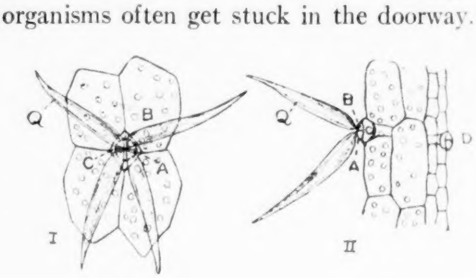
SKETCH OF (*A*) TRAP SET; (*B*) TRAP SPRUNG.

A little fish comes along and by a flick of its tail or a bump of its nose happens to strike the trigger hairs on the lower part of the door. These by their movement distort the bottom edge of the valve and cause it to swing clear of the threshold, and at the same time the walls of the trap expand. The sudden inrush of water carries with it the tail or the snout of the fishlet, and head or tail is held fast by the valve. The inrushing water and the natural elasticity of the walls of the bladder bring this back to its rotund condition as seen in Figure 10*B*. The trap has been activated and the prey secured.

It must be emphasized that these movements of bladder and trap are not activated by any contractile protoplasmic motor body. That the response of the bristles is purely mechanical is seen in their opening the valve when touched even though they have been killed by iodine. Like activity of the trap (return to "sprung" condition) is seen after its having been immersed in picroformal for half an hour (Lloyd, p. 241).

The bladder is now full of water, and not until it is freed of this can the trap catch more prey—vertebrate or invertebrate. When the valve is freed of any foreign body, helped by the pressure of the water inside, it comes back to its normal set position against the threshold. Then the process of removing the water is begun. This is effected by certain specialized cells, the "quadrifid cells" which line much of the interior of the bladder. These cells are shown in Figure 11, copied from Dean's Plate III (1890). Being without cuticle, they absorb the water within the bladder and pass it through other noncuticularized cells to and through the like cuticle-free outer cell *D*. Thus, presently most of the water in the bladder (about 88 percent, according to Hegner) is excreted, the walls become indented, and the trap comes back to the set condition shown in Figure 10*A* and is ready for another little fish or other prey.

One can understand that minute organisms, diatoms, desmids, protozoans, small crustacea, etc., will go in with ease with the sucked-in water. But how about long worms, mosquito larvae, etc.? These larger organisms often get stuck in the doorway.



After Dean, 1890

FIG. 11. SPECIALIZED CELLS

THE QUADRIFID (*Q*) AND ADJACENT BLADDER CELLS IN SURFACE VIEW (I); IN SECTIONAL VIEW (II).

The sheet of the flexible valve must wrap around these when stuck and, acting as a plug, make the doorway tight. A worm with the forepart outside has been seen to break in two—whereupon the forepart swam away. In the case of a mosquito larva

similarly caught, the anterior parts were gradually drawn in—presumably, the water was exhausted and the softened larva engulfed by repeated suckings-in. Lloyd (p. 253) figures and describes progressive experimental intaking of a soft, slender shred of coagulated albumen. But the explanation becomes more complicated when little fishes are concerned.

How little fishes activate the trap and are caught has already been described. But it is interesting to speculate on their ultimate fate. The flexible curtain part of the valve must clamp down on the body so as to permit no further ingress of water—it and the body forming an effective plug (Lloyd, p. 251). The fishes must die from strangulation of the circulation if from no other cause. If the head of the fish, including the pectoral fins, is swallowed, as various figures show, then there is no hope for it. It can only move inward. Various observers have noted that many fishes push forward until the head reaches the opposite wall of the bladder. It should be noted that fishes on meeting an obstruction tend to drive forward. Eventually a small fish might be completely engulfed as portrayed by Halperine (Fig. 7). However, it is notable that no such occurrence has been found in the records quoted above.

When the fishlet is caught by the tail, the final result becomes more difficult of explanation. If the baby fish is very small and the bladder large enough, as the body softens it might gradually but slowly be sucked in. In the case of a larger fish, decomposition might set in after death, and, if and when some predator (a crustacean?) seizes the head, this might be torn off and carried away. Certainly Halperine's larval fish with the yolk sac (Fig. 6) could never be engulfed—unless the yolk sac sloughed off. The fate of Halperine's (and other's) little fish swallowed head and tail by two bladders (Fig. 6), I leave to the reader's imagination.

The question of the fate of the organic bodies taken into the bladders, like Banquo's ghost, will not down. Utricularia, like all plants, must obtain some nitrogenous food. Since it is a rootless aquatic plant, one might expect that it would absorb its nitrogenous food directly from the water by means of its body cells. But it has been found that not only the outer bladder cells but also the general epidermis of the plant are covered with an impervious cuticle. Since the plant has to have nitrogenous food, can it be that this has led to the development of traps to procure such food? Most terrestrial plants that have traps secrete digestive ferments.

Since the utricles of the various aquatic bladderworts vary in size from 1.5 mm. to 5 mm., it is very difficult to ascertain whether they have any digestive ferments. Evidence has been alleged pro and con. But in any case they surely feed on the invertebrates they ingest and digest with or without the help of bacteria. They must absorb this soluble food by their quadrifid cells (Fig. 11) and transmit it by osmosis through the noncuticularized adjacent cell walls to other cells of the wall of the trap.

Perhaps the fish bodies just break up in the same way as do the invertebrates. This matter is very obscure, and, since no investigator has even alleged that the bladders digest and absorb nitrogenous matters from the fishes more or less accidentally taken in, it is necessary to leave to the future the matter of the fish as food.

With all the evidence before us, it must be decided that while the bladderwort does catch fishes this is more or less an accidental, and not necessarily a purposive, action. And most assuredly the plant is not to be called a fisheater. Hence from this standpoint it is not an enemy of the pisciculturist as mistakenly alleged by Simms in 1884. However, since it takes into its bladders and destroys vast numbers of the minute aquatic plants and animals on which little

fishes depend for their food in their earliest days, it is in this respect an indirect enemy of the fish culturist.

The evidence of the amount of Utricularia's intake of the food of young fishes is too extensive to be given here.

Finally, let it be said that one of my purposes in writing this article has been the hope that its publication will lead someone, favorably situated for studying the bladderwort in wild waters, to determine how much fish-catching is done under such natural and unconfined conditions and to illustrate his observations by photographs.

REFERENCES

BATH, W.
1905 Ueber Kaulquappen in den Fangblasen von *Utricularia vulgaris*. *S. B Gesells. Naturf. Freunde Berlin*, 153–155, 2 figs.,

CARPENTER, ALFRED
1884 A Carnivorous [Marine] Plant. *Nature*, London, **30**, 289.

DEAN, BASHFORD
1890 Report on the Supposed Fish-eating Plant [Utricularia]. *18. Rept. Comm. Fisheries State of N. Y.*, 1889, 183–198, 4 pls.

DELACHAUX, THEODORE
1894 Fischfressende Pflanzen. *Schweiz. Fischerei Zeitg.*, **2**, 45.

GREEN, E. E.
1903 [The Catching of Little Fish by Utricularia in Ceylon.] Quekett Microscopical Club, 2 ser., **8**, 483–484.

HALPERINE, E.
1885.1 Plantes Piscivores. *La Nature*, Paris, **13**, 84–86, 2 figs.
1885.2 Piscivorous Plants. *Bull. U. S. Fish Comm.*, 1885, 353–356, 2 pls.

HARTING, J. E.
1906 *Recreations of a Naturalist.* London (Fishes Trapped by Bladderworts, 230–233.)

LLOYD, FRANCIS ERNEST
1942 *The Carnivorous Plants.* Waltham, Mass. (The Utricularia Trap, Chap. XIV, 233–267, pls. 20–38.)

MOSELEY, H. N.
1884.1 A Carnivorous Plant Preying on Vertebrata. *Nature*, May 22, **30**, 81.
1884.2 The Fish-eating Utricularia or Bladderwort. *Bull. U.S. Fish Comm.*, July 30, **4**, 261, pl.
1885 On the Trapping of Young Fish by the Water Weed, *Utricularia vulgaris*. *Rept. Brit. Ass. Adv. Sci.*, 1884, 281.

SIMMS, J. E., JR.
1884.1 [A fish-eating Plant, Utricularia.] *Fishing Gazette*, May 31, 1884.
1884.2 *Utricularia vulgaris* [An Enemy of Fishes]. *Nature*, **30**, 295–296, 3 figs.
1884.3 A Fish-eating plant. *Bull. U. S. Fish Comm.*, July 30, **4**, 257–259.

SKUTCH, A. F.
1928 The Capture of Prey by the Bladderwort: A Review of the Physiology of the Bladders. *New Phytologist*, **27**, 261–297, 2 figs.

WALTER, EMIL
1894 Ueber fischfressende Pflanzen. *Allg. Fischerei Zeitg.*, **19**, 358–361.
1899 Die Brutschädlinge der Fische und die Mittel zur ihrer Vernichtung. Neudamm. (Utricularia, 11–12, pl.)

FUN WITH FOSSILS*

By KATHERINE VAN WINKLE PALMER
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FUN with fossils is the thrill of finding the unexpected. One never knows what may be turned up in a layer of rock. One may unearth the bones of a horse with three toes where now roams a horse with only one toe; one may chisel from a mountainside the skeleton of a fish preserved ages ago though there may be no piscatorial luck in the stream below; one may dig the leaves of ginkgo, magnolia, or sweet gum from the rocks of "Greenland's icy mountains" or, at heights of over 7,000 feet in the Rockies, wrest impressions of the delicate tissue of a fossil jellyfish. The search is full of adventure, fun, many times failure, but always hope.

Henry Fairfield Osborn contrasted the hunter of living creatures with the hunter of fossils. He said: "The hunter of live game, . . . is always bringing live animals nearer to death and extinction, whereas the fossil hunter is always seeking to bring extinct animals back to life."

Delving into the rocks to obtain the secret of the past is a gamble, but it is a game which people from the rich man to the chief enjoy playing.

In the city of New Haven, there was once a certain rich man by the name of O. C. Marsh, who had so much fun with fossils that he became one of the "three founders of the science of vertebrate paleontology in America." Because this man wanted all his time to study and explore for fossils he served (until his last years) as a professor at Yale University without salary. He had persuaded his rich uncle, George Peabody, to establish and endow a museum of natural history at Yale. And to this museum were brought the many fossil bones of dinosaurs, flying reptiles, marine lizards, birds with teeth, extinct mammals, immense and small, which Marsh had collected or had had collected during the time between 1868 and 1892. There were over 3,000 shipments on which he spent $200,000 of his own money. In addition, he had had dug enough fossils for the U. S. Geological Survey to fill 9 freight cars and cost the federal survey nearly $150,000.

Living at the same time, in the "City of Brotherly Love," was another rich man, Edward D. Cope, who also had fun with fossils in a big way. He was one other of three founders of American vertebrate paleontology. He built up a great collection of fossil reptiles, mammals, birds, and much else, which was ultimately bought by the American Museum of Natural History.

Those two great rivals, the brilliant Cope and the able Marsh, with their organized expeditions of expert collectors in the Great Plains and Rocky Mountain areas in the pioneer days of the second part of the eighties, engaged in a furious race to obtain and describe the bones of extinct creatures of the past. Although their methods became cutthroat and their feelings bitter, they built up vast collections which, together with their own brilliant and scholarly studies and those of subsequent gifted, trained, and leading fossil students, have made possible the beautiful, scientific, and popular restorations and learned treatises of the Peabody Museum, the American Museum of Natural History, and the U. S. National Museum.

But one does not need to be wealthy or go thousands of miles to have fun digging fossils from the earth. We may be re-

* From an address, American Nature Study Society Dinner and Annual Meeting, Boston, December 27, 1946.

minded of Robert Dick (1811–66), the poor, humble, and modest baker-naturalist of Thurso, in the dreary northernmost town of Scotland. Dick, self-educated, earned his daily bread by baking it. Never neglecting his baking, he timed his duties so that he could frequently start at midnight on his roamings over the countryside. He loved all nature and knew its forms well, whether fern, flower, insect, shell, stone, or fossil fish. Through wind and rain he tramped, 16, 20, 50, or even 80 miles, but he never traveled beyond the limits of his native county of Caithness. Here, carrying "3 pounds of iron chisels in his trousers pocket, a 4-pound hammer in one hand, and a 14-pound smiddy forehammer in the other; and his old beaver hat filled with paper and twine," he would leave the drudgery of his bakeshop and ramble amongst the objects he loved. Dick discovered and collected the remains of queer, primitive, extinct fossil fish of the Old Red Sandstone or Devonian rocks. Many of the specimens were glorified in the writings of another famous Scottish fossil-fish collector, Hugh Miller. Some of Dick's and Miller's fish reached the great Agassiz and thereby formed the basis for many of Agassiz' fish descriptions. Dick's was the joy of original discovery, and his fun was cracking the rocks to unearth the unknown creatures of the past. As he puts it in rhyme:

> Hammers and chisels an' a'
> Chisels and fossils an' a'
> Resurrection's our trade; by raising the dead
> We've grandeur an' honour an' a'
>
> Hammers and chisels an' a'
> Chisels and fossils an' a'
> In spite of the devil we'll dig as we' able
> Hurrah for the hammers sae braw.

Even poverty does not prevent exploring in science. Lamarck, France's illustrious botanist, zoologist, and paleontologist, at a time when thinking was fettered by the biblical version of creation and the Flood, gave to the world for the first time a scientific, intelligible conception of main trends in evolution and an appreciation of the vastness of time not previously grasped. Throughout his eminent career, Lamarck lived on a pittance, and when he died there was naught to buy him a decent grave. His body, like that of a common beggar, was thrown into the general pauper trench, from which the bones were removed after a certain period and dumped in the catacombs of Paris; the place of his burial will ever remain unknown. Lamarck is called the founder of invertebrate paleontology, and his position as naturalist and philosopher is among the great. It was in the vicinity of Paris, from the rich Tertiary rocks, that he gathered the remains of mollusks, which he described and from the facts formulated general evolutional truths.

To some, the joy of having fossils could only be satisfied by keeping what did not belong to them. In 1848 the skull and carapace of a glyptodont, the ancient relative of the modern South American armadillo, was discovered in Montevideo. This fossil was presented to Vice Admiral Dupotet, who took it to France to give to his home city of Dijon. On the way, he left the specimens for exhibition in the Jardin des Plantes in Paris. When Dupotet later tried to remove his fossils, the authorities of the Jardin des Plantes had become so enamoured of the glyptodont that they refused to part with it. Unsuccessful in obtaining his own property, Dupotet made a will bequeathing the glyptodont to the Museum of Dijon and died, leaving his wife to carry on in its behalf. She eventually was partly successful, for the Jardin des Plantes parted with the carapace but retained the skull. Thus the skeleton of the glyptodont became a "house divided." When Professor Henry Ward, of the early Ward's Natural History Establishment, went to Europe to make casts of representative fossils in the various museums, he asked

permission of the Jardin des Plantes to make a cast of the skull of the glyptodont. He was at first refused, but later permission was granted provided he did not sell a replica to the Museum of Dijon. Ward also asked the Museum of Dijon to be allowed to make a cast of the carapace. They too refused but eventually gave permission if he would promise not to sell a cast to the Jardin des Plantes. These promises Ward of course gave, and he returned home with casts of skull and carapace of the fossil. These he combined and later distributed duplicates to the early institutions of our country. Many of those Ward casts are still available in remnants of the museums of the Gay Nineties, where they were gazed at with awe. So, if you ever see one of those large replicas, particularly identified by its heavy armored carapace, like a coat of mail, and the long spiny tail, or one with a clublike tail, like the cudgel of the funny-paper cave man, ponder the moral of how much fun stolen property can lead to!

The life of a doctor is traditionally busy. Yet physicians have been a leading group in the pursuit of natural history. Perhaps a form of relaxation from the arduous duties of visiting the living may be obtained from association with the silent relics of the past. Dr. John Collins Warren, born in Boston in 1778, Professor of Anatomy in the Harvard Medical School, one of the founders of the Massachusetts General Hospital and the McLean Asylum for the Insane, onetime president of the Boston Society of Natural History, and perhaps best known for having been the first to use ether in surgery, took time off occasionally to enjoy working with bones of prehistoric creatures. The most nearly complete and perfect skeleton of a mastodon, one of the extinct proboscidians which roamed North America 20,000 to 30,000 years ago, was found in the region of Newburgh, N. Y. In 1846 Dr. Warren purchased that skeleton for $5,000 and subsequently built a fireproof building at 92 Chestnut Street in Boston to house it. That building became famous as the Warren Museum, and to it the doctor brought specimens of mastodons from all over the world; he finally wrote a fine book on the subject. In 1906, many years after Warren had ceased practicing in this world and the last of his heirs were no more, the Warren collections were sold to the American Museum of Natural History. In 1908 the Warren mastodon was given a new mounting, a shampoo, and glorified by the paintings of its restoration by Charles R. Knight. It is now exhibited as one of the prize showings of the Museum of the city of the Great White Way.

The profession of law may well do honor to one of its profession, Sir Charles Lyell, who because of his love for rocks and fossils finally gave all his time to that pursuit. He wrote much and well and when he died in 1875 he was properly buried in Westminster Abbey, for it was said he was "the most philosophical and influential geologist that ever lived." He traveled from England over the world, including four trips to America. Amidst the fun that he had in collecting fossil sea shells from certain of the rock layers of France and Italy, he contemplated the fact that in each area the percentage of the fossil shells which appeared like those living today was different in each of the four places. And when the percentages were calculated it was found that those in the Paris Basin were the least like the Recent or present-day forms, those in southern France were less like the Recent, those in central Italy were more like the Recent, and those in Sicily were the most like the living sea shells. So Lyell translated the geological history of clams and snails into Eocene, Miocene, Pliocene, and Pleistocene, names which give us handles to talk about parts of the great periods of time previous to our own.

But besides being of philosophical and

scholarly use, the love of fossils may have a practical application. One of the most unusual of merchants was the female fossilist Mary Anning, who, in 1810, a child of eleven, set up and then continued until her death a fossil shop in her native town, the watering place of Lyme Regis in west Dorset on the southern coast of England, near the border of Devonshire. The cliffs of Lyme are famous for the wealth of fossils which weather from their flanks and are strewn along the beach or lie half buried in the clays. There the vertebrae, or "verterberries," in the Dorset dialect, of strange Mesozoic fish, sea reptiles (the ichthyosaurs and plesiosaurs), the remains of ammonites and belemnites (extinct cephalopods), primitive cuttle fish, and many other queer fossils are common wares in the village stores. Both living and fossil fish have been seen for sale on the same counter.

Mary Anning became the Tiffany of the fossil vendors of her day. Through her skill foremost scientists were provided with many remarkable and perfect specimens, and from her stores the visitors to the seashore were furnished curiosities. When selling a fine six-foot ichthyosaur to the King of Saxony and signing her name to the transaction, she quietly and concisely summed up the status of her reputation: "I am well known throughout the whole of Europe." At her death and down through the ages, the geological world has paid tribute to the talent and labor of this female fossilist.

The pleasure derived from the study of fossils may also be a panacea for those who suffer the headaches of public affairs. Thomas Jefferson, when Vice-president of the United States, was elected President of the American Philosophical Society in Philadelphia. This man who wrote the draft of the Declaration of Independence and helped frame the constitution of Virginia, along with many other important documents, in 1797 read to the members of the Philosophical Society a paper entitled "A memoir on the Discovery of certain Bones of a Quadreped of the Clawed Kind in the Western Parts of Virginia." He named his "Great Claw" *Megalonyx*. Later Jefferson's name was perpetuated among the names of the animal kingdom by his giant ground sloth being named *Megalonyx jeffersoni*. While President in 1806, when political debates were many, Jefferson had brought to the White House many hundreds of fossil bones from Big Bone Lick in Kentucky. These relics occupied an empty room in the first house of the land, and the President spent happy moments in this sanctum when not engaged with affairs of state. But such pursuits in science did not strike the public as anything but ridiculous, and in squirtish fashion William Cullen Bryant vented his spleen in poetical satire:

> Go, wretch, resign thy presidential chair
> Disclose thy secret measures, foul or fair
> Go, search with curious eyes for horned toads
> 'Mid the wild wastes of Louisiana bogs
> Or where the Ohio rolls his turbid stream
> Dig for the huge bones, thy glory and thy theme.

Thus from the parade of human endeavors have been picked examples to show that fossils have delighted the soul and stimulated the mind of rich man, poor man, the beggarman, and even the thief, the doctor, the lawyer, the merchant, and the chief.

THE NUMBERS AND DISTRIBUTION OF MANKIND*

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THE problems presented by the distribution of the human population over the surface of the land, and its relations to the natural resources of the earth, form the principal subject matter of human geography.[1] Our knowledge of these matters is still very inadequate. There are wide margins of error in the available statistical material,[2] and still wider gaps in our knowledge of the earth's resources. Yet it seems worth while to attempt to set down some of the facts bearing on these problems as fully as possible.

In this discussion I shall attempt to consider briefly only three of the groups of factors in these problems:

1. The actual magnitude of the present human population and the main features of its distribution over the land surface.
2. The relation between the distribution of the population and that of the fertile lands from which the food of mankind is obtained.
3. On the basis of the first two factors I have ventured to estimate the population capacity of the world on some existing standards of production and consumption.

Numbers. The first question is, How many people are there in the world today? It is not possible to answer this question very exactly. In most of the lands of Western civilization, and in many lands under Western control, fairly reliable censuses[3] have been taken. So we can state the numbers of the inhabitants of Europe and North America, of the countries of the South Temperate Zone, and of Japan and India with some approach to accuracy. But for the large population of China, and for the intratropical lands of the Americas and Africa, we have only estimates of extremely varied value; some of these estimates are based on partial censuses, some are hardly more than guesswork.

Thus there is necessarily a wide margin of error in all estimates of the world's population, which should be remembered in studying the figures in Table 1.

TABLE 1

ESTIMATES OF THE WORLD'S POPULATION[4]

Authority	Date	Population in Millions
E. Levasseur	1908	1,626
Sir G. H. Knibbs	1914	1,649
Times' Atlas	1921	1,646
International Institute of Agriculture	1921	1,820
Statistical Yearbook of the League of Nations	1931	2,025
Statistical Yearbook of the League of Nations	1940	2,145

These estimates do not form a concordant series. In Europe and North America the chief areas of doubt were Russia and Mexico, respectively. In Asia the whole difference may be explained by various estimates of the population of China, but there is equal uncertainty as to the numbers of the peoples of southwest Asia. There were wide differences in the estimates of the population of Africa, which illustrate the difficulty in respect to the numbers of barbarian peoples. Estimates of the population of the Belgian Congo have ranged from 30 millions down to 8 millions.[5]

Table 2 states some of the recent estimates of the population of China to illustrate the differences in regard to the principal area

* From the A.A.A.S.-B.A.A.S. Exchange Lecture, Boston, December 30, 1946.

TABLE 2
POPULATION OF CHINA AND ITS DEPENDENCIES[6]

Authority	Date	Population in Millions
Mingchingpeng Census	1910	324
Government Gazette, Pekin	1911	315
China Continuation Committee	1918	441
Chinese Post Office	1920	428
Times' Atlas	1921	321
Chinese Maritime Customs	1922	443
Chinese Post Office	1922	433
Statistical Yearbook of the League of Nations	1931	450?
Ministry of the Interior (Nanking)	1931	475
Statesman's Yearbook	1931	486
Statistical Yearbook of the League of Nations	1940	450?
Statesman's Yearbook	1946	458

of doubt in estimating the total numbers of mankind.

The census of 1910, which was the basis of the estimate of 1911 and perhaps also for that of the *Times' Atlas*, was a census of households. The multiplying factor (the assumed average number of persons per household) was not the same in all the provinces and is open to doubt.

From the figures here given it appears that the population of the world has increased by about 25 percent since 1911 and that of China by nearly 50 percent. But since 1911 China has suffered from revolution, followed by years of internal disorder, from civil war, and from foreign invasion on a very large scale. There have also been floods and famine and pestilence. The extent of these disasters and their persistence over more than 30 years make it unlikely that there has been any considerable increase in the population of China over this period. In India the influenza epidemics of 1918–20 almost canceled the natural increase of population for the intercensal decade 1911–21. Europe has undergone two great wars and the resulting famines and pestilence since 1914; Russia has also suffered revolution, civil war, and further famine. These facts taken together make it improbable that there has been any large increase in the total world population since 1914, in spite of the growth in the New World.

In view of these doubts and of the variations in many of the estimates which have been quoted, it is impossible to give an exact figure for the world's population. The total is probably near 2,000 millions, with a wide margin of error.

Growth. The experience of the civilized lands during the last two centuries has accustomed us to the conception of a continually increasing population. From 1801 to 1921 the population of England and Wales multiplied more than fourfold[7] in spite of a considerable emigration. Since 1800 the total population of Europe has increased from 175 millions[8] to 500 millions, in spite of the emigration of not less than 40 million[9] people. Under especially favorable conditions some smaller populations have increased even more rapidly. The French Canadians now number about 4 millions. Practically all of them are descended from the 5,800 immigrants who reached Canada before A.D. 1680, when immigration from France ceased.[10] This gives a six hundredfold increase in 250 years.

During the first decade of this century the mean rate of increase in the countries which had regular censuses was 1.159 percent per annum. At this rate the numbers would be doubled in a little more than 60 years.[11] If this had been the average rate of increase in the past, the whole of the present population of the world would be descended from one couple living near the end of the first century A.D. If it could be maintained in the future, then in another thousand years the earth would have about 250 millions of millions (25×10^{13}) of human inhabitants, i.e., more than one to every square yard of land. Such

calculations make it very obvious that the recent average rates of increase among the civilized peoples are far greater than those which existed in the past, and also that such rates of increase cannot be maintained for any considerable time.

Evidently we have been living in a period of exceptionally rapid increase of population. But it is clear that we are approaching the end of that period; for the birth rates are now falling, even more rapidly than the death rates, in a large part of the civilized world. While in the past the direct check to too rapid an increase in numbers was usually the existence of a high death rate, and in particular of high rates of infant mortality, it is now attributable chiefly to a fall in the birth rate. Mankind is able to choose which of these two checks shall be applied; but one of them must be. If the naturally rapid increase in numbers is not controlled by human acts, the appeal will be to the ancient trinity of "War, Pestilence, and Famine." For the surface of the earth is incapable of expansion; and its resources, though great and capable of much fuller utilization, are limited.

We may note very briefly the conditions which made possible the great and sudden expansion in the numbers of the European peoples in the nineteenth century. Evidently these conditions affected the English-speaking peoples to a greater extent than any others, for their numbers have increased ninefold since the beginning of the last century. They now form more than a fourth of all the peoples of European origin, whereas in 1800 they were less than one-eighth.

It is clear that this particular expansion is chiefly due to the peopling of North America, for that continent now contains two-thirds of the English-speaking peoples, whereas it contained only one-fifth of them in 1800.[12] The growth began with the Industrial Revolution, when the applications of mechanical power increased the production of manufactured goods and so led to an increase in the populations of the industrial areas. The increased demand for food was at first met by a more intense cultivation of the homeland, but the insufficiency of this source of food was shown in the "Hungry Forties" of the last century. The pressure of a hungry people removed the tariff barriers which had hindered the free import of food; improvements in transport made the virgin lands west of the Appalachians accessible; and the population of Great Britain multiplied on a food supply obtained from overseas. The demand stimulated the colonization of North America and the even greater increase of its population. But there is little likelihood of the discovery of another "New World" to allow another such expansion of numbers, until man conquers the equatorial jungles.

Distribution. The final limiting factor to the growth of population is that of the food supply; and since man must obtain practically the whole of his food from the land,[13] the next important questions in this study are: What is the extent of the available land? and How much of this land is capable of being used for the support of mankind by the production of materials for food, shelter, and tools with which to satisfy human needs and wants?

The area of the lands outside the polar regions is known to a fair degree of accuracy. Omitting the permanently icebound lands, the total area of the remainder, the available land, is about 50 million square miles.[14] Thus, the average density of population is nearly 40 persons per square mile, a figure which may be of some interest as a basis for comparisons; though in fact the density varies very widely, and the most characteristic feature of the distribution of population is its extreme unevenness.

Of the total of 2,000 million people the greater number live in three comparatively

small regions of particularly favorable environment. In the northwest area of the Old World the populous region of Europe is limited on the north by the parallel of 60° north latitude and the upper valley of the River Volga, on the east by the Ural Mountains and the Caspian and Persian deserts, and on the south by the Sahara-Arabian Desert.[15] This region contains more than 500 million inhabitants on less than 3 million square miles of land. In the Far East the similarly populous region, which includes most of China and Manchuria, the Japanese Empire south of 40° north latitude, and Tonkin, is occupied by nearly as many people on an area of barely 1,700,000 square miles. And in India and Ceylon, between the Thar Desert and the eastern edge of Bengal, there are 400 million people on about a million square miles of land. Thus in these three major populous regions of the Old World there are crowded together nearly two-thirds of the world's population on one-eighth of the available land (Table 3).

TABLE 3

THE FOUR MAJOR HUMAN REGIONS

Continuous Habitable Region	Area in Millions of Sq. Mls.	Population In Millions	Population Per Sq. Mi.	Central Latitude
Europe	2.8	520	186	50°N.
Eastern North America	1.9	130	52	40°
Far East	1.7	500 (?)	292	35°
India	1.0	400	400	25°

There is a fourth region of the same type in eastern North America which is comparable in extent. But, since it has been accessible to civilized man for only a few generations, it is not yet fully occupied; and it carries only the moderate population of about 130 millions on a little less than 2 million square miles of land.

Nowhere else on the earth is there any similarly large area of dense population, though the island of Java is as densely peopled as England, and parts of West Africa have more than 40 inhabitants per square mile. In other regions there are a few dense clusters on small areas around large cities, especially in South America and Australia. But outside the four great populous regions that have been noted the remaining six-sevenths of the available land is very thinly peopled.

Next we may briefly consider the reasons for this, at first sight peculiar, distribution. Rather more than three-fourths of mankind dwell in the Old World, by which is meant that part of the earth which has been accessible to civilized men during all the historic period, in contrast to the New World, which has been similarly accessible only since the Age of Discovery at the end of the fifteenth century. The Old World, as thus defined, includes most of Asia, Europe, and Africa north of the Sahara, and nearly half the available land. Over this vast area the population is in fact distributed in general accordance with the food-producing capacity of the various regions. The fertile areas are densely peopled—the barren lands are comparatively empty. All the oases of the deserts are, or have been, occupied; and many of them are crowded. By a process of trial and error, which has already extended over some thousands of years, men have succeeded in establishing themselves in all parts of these lands which can be made to provide subsistence. Though the knowledge and equipment gained by Western civilization in the past two centuries has made it possible to utilize lands which could not be occupied by civilized man before (as, for instance, Siberia), yet the general adjustment of population to natural resources in the Old World is the best available guide to the possibilities of maintaining any comparable masses of population in the newer lands of the earth.

Elsewhere[16] I have estimated the extent of the cultivatable land of the world at 30

percent of the total land area, that is, about 16 million square miles. Hence I assume in the rest of this article that that area, less than a third of the available land, is cultivatable. Another 30 percent may be classed as "productive" but not cultivatable; and the rest (40 percent) is occupied by the deserts (cold and dry).

The productive but uncultivatable third of the land is mainly divided between areas of forest and poor grazing land, such as the mountain and hill pastures of northwest Europe and the semiarid range, or bush, of North America and Australia. The wetter areas of this land are often suitable for forest; so are some considerable areas on the margins of the tundra, where the hardier conifers can grow, although the lack of sufficient summer heat prohibits agriculture. The semiarid regions and the summer pastures of the tundra and the high mountains are likely to remain grazing lands.

The wet, forested lands of the hot belt, which are included in the cultivatable land of our estimate, offer the chief possibilities of any considerable extension of the cultivated land. Everyone who has studied the matter must have been impressed by the contrast between the island of Java, which supports a population as dense as that of England, and the uncultivated wastes of forest and savanna which occupy the greater part of the hot lands. A few other small tracts of these lands are relatively well cultivated and populous, as in parts of the African lakes region, the Benue Valley of Nigeria, and parts of Upper Guinea. In South America there seem to be no correspondingly populous patches, though the vast Amazon lowland is a region very favorable to vegetable life. Here the chief obstacles to cultivation appear to be (*a*) the combination of heat and humidity, which forms a most enervating climate; (*b*) the very marshy character of much of the region, which is deltaic in origin and can only be reclaimed for cultivation by a great expenditure of labor; (*c*) the density of the jungle and the rapidity of plant growth; (*d*) the scarcity of labor; and (*e*) the lack of any immediate incentive strong enough to induce any civilized people to attempt the task of colonizing in this region.

It is significant that the chief crops which are now under cultivation in the hot lands are broadly divisible into two distinct categories. The one includes the trees or shrubs of the plantations, whose produce forms a money crop, such as tea, coffee, rubber, bananas, and oil palms, for export to the populous lands of the mid-latitudes. These crops are usually grown on well-drained slopes in the hilly areas. The other category consists of local food plants, such as the rice and associated annuals of the wet, irrigated flatlands of the deltas and valley bottoms of the East Indies.

Up to the present the efforts of European and North American planters in the hot lands have been directed mainly to the first group of products and therefore to areas of considerable relief. Their plantations and habitations avoid the wet and marshy lowlands. Only incidentally, through the growth of a local food supply for their working people, have they developed cultivation of the second type, as in the rice fields of the Guiana coast. Yet the experience of the planters has sufficed to show the nature of many of the obstacles to be overcome in bringing the fertile lands of the hot belt under cultivation. It justifies the prediction that these lands will be reclaimed for man only under great economic pressure and at the cost of enormous amounts of labor. The peoples of the temperate regions are not likely to migrate to the hot lands in any considerable numbers so long as they can find room in the more attractive lands of their own climatic zones. Therefore man's effective conquest of the equatorial regions will be postponed until necessity drives him to it.

Population capacity. In discussing the numbers of the people who can be supported on the world's resources, which we may call its population capacity, we are in fact studying the possibilities of the food supply. There are three sets of conditions on which we may base estimates.

1. We may assume that the principal foods and the methods of producing them will remain much as they are today; and that the increase of supplies will only be that due to raising the standards of cultivation in backward areas, using improved strains of food plants and animals and making full use of all the cultivatable land.
2. We may make the additional assumption that man will, in the near future, overcome the difficulties of cultivation in the wet lands of the hot belt and add them to his area of cultivation.
3. We may guess at more or less speculative advances in the developments of science applied to agricultural production, which may enable man to increase the food supply very largely.

Also, we should bear in mind that the number of people who can be maintained at any given level of production varies inversely with their standards of living. It seems probable that the civilized peoples will prefer to check the increase in their numbers rather than accept a lower standard of living.

On the first assumption, that the present methods of food production will be extended but not greatly modified, we may calculate the world's population capacity on the bases of France and British India. These lands are chosen because—

a) Both of them ordinarily produce sufficient of their staple foods for their own needs—on their present standards.
b) Both are "old" lands and are fully peopled under present conditions.
c) Fairly reliable statistics are available for both.
d) They offer a contrast in type of climate and have different staple food plants.

France is a fair instance of conditions in one of the long-civilized countries of Europe which is still, under normal conditions, self-supporting in respect of her necessary foodstuffs; and the standards of living of the French are probably a little above the average of those of the rest of Europe. In France no less than 90 percent of the land is classed as "productive" and half of it as cultivated.[17] The density of the population is a little over 400 persons per square mile of cultivated land. At this rate the cultivatable land of the world would be able to provide food for 6,500 million people, more than three times the present population.

In British India the mean density of the population is more than 600 per square mile of cultivated land; so that on the present standards of India the world might maintain nearly 10,000 million inhabitants, five times the present population.

But it should be remembered that in bad years neither France nor India is able to produce all the food needed by her people. After a bad harvest France must import wheat; and a failure of the monsoon rains may bring famine to large areas of India. If the whole world were peopled up to its full normal capacity on these standards of production and consumption of food, it would in fact be overpeopled, and the surplus population would be periodically removed by famine.

Our second assumption is that the pressure due to an increasing population and a falling standard of living may compel mankind to utilize all the cultivatable lands of the hot belt, at least as fully as those of some small areas in it are now used. At this rate that portion of the cultivatable land which lies in the hot belt, nearly a quarter of it, or 4 million square miles, might be capable of producing food[18] for a population as dense as that of Java. That island contains 42 million people on 50,000 square miles of land, of which a little less than 60 percent is cultivatable; so that the density per cultivatable square mile is about 1,200. If we take France as our basis for

the temperate lands and Java for the hot lands, the possible population becomes 9,600 millions, nearly the same as our second figure based on Indian standards.

In relation to the third assumption we should note the existence of such views as those put forward by the late Prince P. Kropotkin,[19] who could see no limits to the productivity of the land and claimed that the food production of England and other countries could be easily doubled by the application of intensive methods of cultivation. Such an increase would, however, more than double the labor cost of the products and so tend to lower the standards of living. It is true that agricultural productivity can be increased by such expenditure of labor and capital, and still more by the application of the results of scientific investigation into its problems. Many optimistic forecasts have been made, but I know of no data sufficient to justify even an intelligent guess at the limits of such productivity.

It is clear from the estimates here given that the world, as a whole, is capable of supporting a population much more numerous than that which it carries today. The immediate problems of overpopulation are limited to some comparatively small areas; and the present-day "pressure of population"[20] is not against the limited resources of the earth but against the various barriers, natural and artificial, which hinder access to those resources. With our present powers of production the world may well be able to support three times its present population in reasonable comfort. But at the rates of increase of 1900–1910 that number would be reached in about a century from now. And the fact that the size and natural resources of the earth are fixed and limited insures that its human population cannot increase indefinitely.

NOTES

1. E.g., Part I of F. Ratzel's *Anthropogeographie* is given to this topic; so also is Part I of P. Vidal de la Blache's *Principes de Géographie humaine*.
2. Because of these difficulties all the figures used in these calculations are round numbers; and none of the resulting estimates should be regarded as more than first approximations. Cf. the General Note, *Statist. Yearb. of the League of Nations*, 1940, 13.
3. Where most of the people can read and write a census can be fuller and more accurate than among an illiterate people. Also, great mobility among a people, as in the United States, makes for less accuracy in the census. No census is quite accurate, but I have no data for a numerical estimate of the error in any census.
4. Levasseur. La repartition de la race humaine. *Bull. Inst. Int. Statist.* 1909, 48–63. Knibbs. The Mathematical Theory of Population. *Appendix A to the First Census of the Commonwealth of Australia*, 1917, 31. *The Times' Atlas*, London, 1922, pls. 5, 7. *Int. Yearb. Agric. Statist.*, 1909–1921, published in 1922 at Rome. *Statist. Yearb. League of Nations*, 1932/33 and 1931/40.
5. East, E. M. *Mankind at the Crossroads*, London, 1924, 100. Levasseur, *op. cit.*, gives 20 millions. *Philip's Handy Reference Atlas*, London, gives 16 millions in 1900 and 20 millions in 1913. *Annuaire Belg. et Congo Belg.*, 1914, gives 15 millions, and in 1945, 10 millions.
6. The first and fourth figures are from the *China Yearb.*, 1922; the second, sixth, seventh, ninth, tenth, and twelfth from the *Statesman's Yearb.*, 1924, 1932, and 1946; the third is from P. M. Roxby's The Distribution of Population in China, *Geog. Rev.*, January 1925; the fifth is from pl. 7 of the *Atlas*.
7. From 9 millions to 38 millions; figures from the *Census Reports*.
8. Estimate of Levasseur, *op. cit.*, and see J. Haliczer's The Population of Europe, 1720, 1820, 1930, *Geography*, 1934.
9. To the United States alone more than 33 millions. Warne, F. J. *Annals of The Amer. Acad. of Pol. and Soc. Science*, January 1921.
10. Marquis, G. E. *Social and Economic Conditions in Canada*. The American Academy of Political and Social Science, May 1923, 7.
11. Knibbs, *op. cit.*, 31. See also article by F. Shirras, *Econ. J.*, March 1933.

12. Populations of the English-speaking peoples in millions (whites only).

1801	British Isles	15,9	1931	British Isles	49
			1941	Australia and New Zealand	9
				South Africa	1
	Canada	0,1		Canada and Newfoundland	8
1800	U. S. A.	4,3	1940	U. S. A.	119
	Totals	20,3			186

13. It is not possible to determine with any precision what amount or proportion of human food is obtained from the sea. This does not affect the value of our estimates of population capacity, since these supplies are included in the resources of the existing populations on which those estimates are based.
14. FAWCETT, C. B. The Extent of the Cultivable Land. *Geog. J.*, December 1930.
15. See also MACKINDER, SIR H. J., *Democratic Ideals and Reality,* London, 1919; and FAWCETT, C. B. Centres of World Power, *Sociol. Rev.*, April 1926, and The Changing Distribution of Population. *Scot. Geog. Mag.*, November 1937.
16. *Op. cit.* Note 14 above.
17. *Int. Yearb. Agric. Statist.*
18. It is well to note that the possibilities of transporting perishable foods are likely to improve still more. Hence such an increased amount of food might be used to feed the people of the temperate lands so long as their economic and military power enabled them to take it.
19. KROPOTKIN, P. *Fields, Factories, and Workshops.* London, 1898, and later editions.
20. FAWCETT, C. B. Pressure of Population. *New Commonw. Quart.*, London, January 1943.

UNNUMBERED SPRINGS

Unnumbered springs have gone before
This day that floods its golden store
Of radiance upon the heart;
Yet all men rediscover, start,
Beside this gate, this ancient door.

Lovers in legendary lore
Have thrilled to hear the thrush downpour
His burthen of remembered art
Unnumbered springs.

Spring is not new; ambassador
To Pterodactyl, Dinosaur,
Older than chaos or the chart
Of God . . . Cretaceous seas apart,
Pteranodon, new-flying, bore
Unnumbered springs.

BARBARA WHITNEY

THE SENATE PONDERS SOCIAL SCIENCE

By GEORGE A. LUNDBERG

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ON July 3, 1946, the United States Senate passed a bill to establish a National Science Foundation, after excluding the section designed to make the provisions of the bill applicable also to the social sciences. Since the social sciences must perhaps depend in the future largely on public provision for their advancement, the reasons assigned for excluding them in the most comprehensive legislation yet proposed for the advancement of science is a matter of some interest from several points of view. In the first place, the discussion of the matter in the committee hearings and on the floor of the Senate gives us some indication of the present attitude of legislators toward the social sciences. In the second place, an analysis of this attitude affords us clues as to the nature of the obstacles to be overcome before the social sciences can expect to share the prestige and the support accorded the other sciences.

The present article will deal only with the public expression of attitudes as found in the *Congressional Record* for July 1–3, 1946, and in the reports of the preceding committee hearings.[1] I have no "inside" information regarding the "real" or "true" views of everyone concerned, or of lobbies or "politics" involved. Likewise, this article does not deal with the efforts of individuals and organizations for or against the inclusion of the social sciences, except as these find expression in the published record. Finally, I am not primarily concerned with a criticism of the senators opposing the legislation as a whole or the inclusion of the social sciences in particular. Their attitudes may be regarded as entirely sincere and as a true reflection of public opinion on the subject of the social sciences. It is more pertinent to inquire into the possibly legitimate grounds for such views as exist, in the actual behavior of social scientists themselves at present. While taking this impersonal view of the Senate's action, it is proper to compliment the sponsors and certain supporters of the bill on their earnest efforts on its behalf. Special credit in this connection is deserved by Senator Magnuson, of Washington, Senator Kilgore, of West Virginia, Senator Fulbright, of Louisiana, and Senator Thomas, of Idaho.

The bill as reported favorably by the Committee on Military Affairs included the social sciences. Let us therefore consider first the record of the bill on the Senate floor, confining ourselves to the discussion leading up to the exclusion of the social sciences. Later we shall review the more extensive discussions of the subject at the hearings.

On the first day of the debate Senator Radcliffe, of Maryland (A.B., Johns Hopkins, 1897, and Ph.D., 1900), made certain justifiable remarks regarding the danger of crackpots and "applied" social science research with specific references to "men addicted to isms" (8166) and "wild-eyed so-called research" (8167). (Senator Radcliffe, however, voted for the inclusion of the social sciences.) At this point also there arose the question as to the definition of social science. Senator Fulbright had the floor, and the following discussion ensued:

SENATOR FULBRIGHT: I asked an able scientist yesterday if he would define social science. I had been worrying about that. He said in his definition, "In the first place I would not call it science. What

is commonly called social science is one individual or group of individuals telling another group how they should live" (8164).

SENATOR WILLIS (B.A., Wabash College, 1896; M.A., *honoris causa*, 1902): I wonder if that is not a pretty good definition (8164).

It may be stated here that the general tone of the discussion throughout the three days indicated that most senators were of the opinion that the above was a pretty good definition. There is evidence too that one reason why provision for research in the social sciences appeared to the senators to be unnecessary was that, after all, we already know the answer to social problems. For example, Senator Willis delivered himself of the following: "It is a question of keeping selfishness in restraint, that is all" (8165).

I suspect that the above represents a major type of reason for the exclusion of the social sciences from the provisions of Senate Bill 1850. However, the assigned reasons which finally were conclusive seem to have to do with the feeling that the legislation was for the purpose of promoting basic research and that the most that could ever be true of the social sciences was that they had to do with practical applications and planning. For example, Senator Hart, of Connecticut (Naval Academy, 1897, Admiral, Ret., 1945), one of the two principal opponents of the inclusion of the social science provision, made the following statement:

SENATOR HART: Support of social science and research should be limited to studies and planning. That is a very good and practical reason why the social sciences should be omitted entirely from the bill which is primarily for improvement in the basic sciences... (8216). The fact is that social studies and basic science are not sufficiently alike either to be joined by the same legislation or to be administered by the same organization (8217).

This point of view was also much stressed by the chief opponent of the social science provision, Senator Smith, of New Jersey (B.A., Princeton, 1901; L.L.B., Columbia, 1904; L.L.D., *honoris causa*, Brussels, 1930, Princeton, 1945; Executive Secretary of Princeton University, 1919–27, lecturer, Department of Politics, Princeton University, 1927–30). Both Senator Smith and Senator Hart had recently become members of the Senate to fill unexpired terms and both had served only about one year. There was on the part of the senators much deference to Senator Smith on account of what is referred to as "his distinguished academic career" as giving him special qualifications to speak on this subject.

SENATOR SMITH: I should like to see the social sciences given aid, but I think their problem is such a different one that the two should not be joined in this bill... (8233). [Social science research] definitely has nothing to do with this bill. The bill has to do with basic research in pure sciences as they are understood in the academic world (8237).

Consider the further remarks of Senators Hart and Smith:

SENATOR HART: In the first place, no agreement has been reached with reference as to what social science really means. It may include philosophy, anthropology, all the racial questions, all kinds of economics including political economics, literature, perhaps religion, and various kinds of ideology.... There is no connection between the social sciences, a very abstract field, and the concrete field which constitutes the other subjects to be dealt with by the proposed science foundation. Mr. President, this may well be a field in which the Government should proceed to foster and subsidize research; but I submit that it has no place in this bill. This is a bill for the promotion of research in the fundamentals of natural sciences.... Furthermore, Mr. President, what to my mind is one of the greatest objections to its inclusion in the bill is the fact that no board, no administrative organization which we could set up could possibly be adequately qualified to administer such policies and carry on work in two fields so absolutely diverse ... (8348–49).

SENATOR SMITH: I have conceived of this bill, as I have said so many times, as a bill for research in pure science, not in applied science but in pure science. We are trying to subsidize pure science,

the discovery of truth. This has nothing to do with the theory of life, it has nothing to do with history, it has nothing to do with law, it has nothing to do with sociology (8349).

This latter view of the case, coming from a man regarded as an authority on the matter at hand, seems to have carried the day. The principal voice raised to the contrary was that of Senator Thomas, of Utah, who toward the close of the debate delivered the following:

SENATOR THOMAS: Mr. President, no invention, no patent, no scientific development amounts to anything for the benefit of the people anywhere unless it has its social aspect, and for us to assume that we can carry on this great political institution, the Government of the United States, and cause it to develop for the benefit of the people of the United States, without having reference to that great branch of knowledge which is called social science, would be to make the mistake of all time.... If we insert limitations barring social science in this bill, which establishes a great foundation, they will cripple—probably forever—the very things that government wishes to do most (8349).

A few incidental remarks regarding the relationship of academic and research life to politics may be of sufficient interest in this connection to be included in this record.

SENATOR MORSE [referring to his twenty years of experience in education and service on the scholarship and research boards of two institutions]: We have a lot of educational politics in America. If anyone wants to get a graduate course in practical politics I think he has only to belong to the faculty of an educational institution. Certainly that is where I got my training.

SENATOR SMITH: Mr. President, if the Senator will yield to me for a moment, let me say that I am glad to corroborate what he has said. I, too, got my experience in politics there.

SENATOR MORSE: The same remarks may be made in relation to some of the great private foundations. I mean no criticism but it is simply a fact (8359).

A study of the three-day debate on Senate Bill 1850 shows that the matter of the inclusion of the social sciences received no considerable amount of the total attention, which was devoted to other aspects of the National Science Foundation proposal. The question of the inclusion of the social sciences was definitely a side issue. The whole proposal for a National Science Foundation was apparently a somewhat mysterious subject to most of the senators. The following remark is significant in this connection:

SENATOR HAWKES: I wish to say that I am in favor of scientific development, but I personally do not believe that this body understands what it is doing. I have talked to any number of senators and all seem to be at sea and in a fog as to what we are asked to do (8265).

The main reason that the bill finally passed even with the social sciences excluded seems to have been a general feeling that perhaps the legislation had something to do with the atomic bomb or protection therefrom. Coming up, as the bill did, toward the close of a legislative session, there is every reason to believe that Senator Hawkes's observations are correct. The vote[2] to exclude the social sciences, therefore, should perhaps not be taken as reflecting any considered hostility or opposition on the part of the Senate, but simply as a reflection of the common feeling that the social and the physical sciences have nothing in common and that at best the social sciences are a propagandist, reformist, evangelical sort of cult. At the conclusion of this article we shall consider whether the attitudes and behaviors of social scientists themselves do not largely justify the position taken by the senators. But first let us consider the more thorough discussion of the subject as found in the committee hearings on the bill in question.

NOWHERE in the approximately 1,200 pages of hearings reports do we find any vigorous opposition to the social sciences

as such. This was especially true of the testimony of physical scientists. A questionnaire submitted by the Executive Secretary of the American Association for the Advancement of Science to the members of the Council of that organization showed that 67 percent favored inclusion of the social sciences in the bill. As Dr. Meyerhoff remarked in this connection: "Naturally that included all the social sciences but the social scientists are a small number of the Council and the large vote, you see, must come from the people in the basic or physical sciences themselves"(85). From this point of view the record is, in fact, rather encouraging. There are a very large number of references to the desirability of including the social sciences on the part of witnesses who were not asked to testify on that aspect of the matter but who gratuitously suggested it. Such, for example, was the case of Dr. J. R. Oppenheimer, director of the New Mexico laboratories of the Manhattan Project. Speaking of the desirability of providing scholarships for students in the social sciences, he said:

> DR. OPPENHEIMER: I am aware of difficulties of establishing in these fields rigorous criteria of competence and qualification. Nevertheless, at a time when the whole world realizes that many of its most vital problems depend on an understanding of human behavior and of the regularities which underlie the operations of our varied society we should recognize the great benefits which may come—I would like to say which will come—from attracting men and women of prominence to the study of these questions (301–302).

This kind of testimony from the physical scientists was quite frequent.

The objections which occur, like those on the Senate floor, rather take the form of suggesting that, while the social sciences doubtless deserve support, they are so different that they should not be included in this bill. Since that is the ground on which Senator Smith based his opposition on the floor of the Senate, it will be well for us to note the sources and nature of that argument.

Even the testimony that was friendly to the social sciences, however, betrayed a very great vagueness and frequently a gross misunderstanding of what the social sciences are or should be before they can ever hope for support as science. I am not here primarily interested in refuting these erroneous notions, but rather in diagnosing and classifying them. The refutations have been elaborated elsewhere in considerable detail.[3]

What were the principal misapprehensions regarding the nature of social science as revealed in the Senate hearings?

1. *Social science cannot be unbiased.* First of all, there is evident in the testimony before the Senate the deep-seated notion that there can be no such thing as disinterested, unbiased inquiry into social questions. Interestingly, but somewhat discouragingly, one prominent spokesman rather inclined to that point of view was Dr. Isaiah Bowman, who, in addition to being President of Johns Hopkins University, was for some years a member of the Social Science Research Council. He does not appear to have gained from the latter association any deep appreciation of the possibility of basic and unbiased research in the social sciences. Perhaps, in fact, he gained his skepticism from his contact with the Council. He testified as follows:

> DR. BOWMAN: It is well known that so much of human prejudice and tendency and social philosophy enter into the study of social phenomena, that there is the widest difference of opinion as to what constitutes research in many instances in the social sciences. But I would, if I were drafting a bill that paid my respects to that principle, and it is a sound principle that men's field cannot be detached from their researches in the social views, I would still keep two places open in the bill for the play of minds in the social sciences. . . . At such times of national

emergency, when the most critical judgment is required of all our people, the social scientists should be called in as freely as circumstances will permit. The second of my two points respecting the work of social scientists relates to statistical matters (23).

Another college president was even more skeptical about the social sciences, and again it is significant that he also had had some background in the field. Dr. John Milton Potter, of Hobart and William Smith Colleges, Geneva, N. Y., spoke at some length in this vein:

DR. POTTER: I might in a word say that I do not believe a scientist will learn about society by the study of social science as a science. Still less will he learn about it by the establishment of a research project in social science as a science. . . . As a matter of fact, there are some people who think you can extend the strict scientific method into almost any region of human affairs. I don't happen to believe so. I was trained as a historian. I have also had some experience with the so-called sciences (943).

The following discussion then ensued:

SENATOR MAGNUSON: Suppose this Foundation went into certain projects. Wouldn't it be desirable, in your opinion, to have some basic information regarding the social aspects question?

DR. POTTER: Yes, sir.

SENATOR MAGNUSON: What that research may result in?

DR. POTTER: Certainly. Of course. But these things, it seems to me, could be far better supplied by experienced men like Mr. Baruch or, rather, by you gentlemen here in the Senate, so many of whom are experienced lawyers, than by trying to tackle the thing entirely on the academic level.

SENATOR MAGNUSON: Statistics is one part of social science. They are very necessary for any project we may take on.

DR. POTTER: Yes, sir; and statistics are subject to enormous interpretation. It seems to me that to set up an organization with the prestige which such an organization would inevitably have to give the punch of official report to a group of statistics which might be extremely controversial rather than to have these statistics interpreted as they ought to be by the Congress of the United States, which includes men who are themselves experts in politics, political thought, political economy, and public law, would be a mistake (944).

We have here the interesting thought that Congressmen, lawyers, and politicians are more reliable interpreters of statistics than statisticians and scientists. Dr. Potter's further remarks are most illuminating as to his notion of science and its relation to human affairs. He is clearly under the impression that it is the business of science to tell people what they must do with scientific findings as well as what *can* be done:

DR. POTTER: It is not an exaggeration to say that the strictly scientific approach used in the problems of physics, if applied to major international political problems of our time could well produce such answers as (1) economically nonproductive and mentally backward populations should be destroyed; (2) it is cheaper to appease than to oppose a tyrant; (3) we should obliterate the populations of all potential aggressor nations which resist following our advice . . . (946).

A National Research Foundation which promulgates bigger and better atomic bombs, without consideration for fostering the teaching which will help men to seek to know how to live without using these new weapons, would be, in my respectful opinion, a betrayal of the aspirations of most Americans, however well it might fit snugly into the inhuman grooves of systematic scientific research. So would be a foundation which attempted to improve human relations by using laboratory methods of scientific research (946).

One wonders what Dr. Potter thinks social research would be for if not to reveal to men *how* to live without dropping atomic bombs on each other. What, on the other hand, does he consider the true solution?

DR. POTTER: In my opinion Congress should in this bill provide for a division of the humanities—rather than a division of the social sciences, a misnomer. Such a division should not engage in research. Instead, by use of scholarships and fellowships, it should seek to stir concern among young men and women for teaching in those fields of human knowledge in which the accumulated wisdom of our civilization can be made familiar to our use in the schools and colleges of the United States (946).

I am sure no one will be uninterested in the "accumulated wisdom of our civiliza-

tion." A major and most effective portion of that accumulated wisdom is science, and it has been accumulated reliably and has been made effective through scientific research. It is the social scientist's contention that scientific research is needed also in that field to determine how much and what parts of the accumulated lore according to which we attempt to live are reliable wisdom and what parts are dangerous and misleading folk beliefs.

2. *The social sciences are "applied," not "pure" or "basic."* The idea that the laws of sociology are as much laws of nature as are the laws of physics is not brought out anywhere in the testimony, and it seems to be taken more or less for granted by everyone that the laws of sociology could at most be only so-called applied laws comparable to the practical technology of social work and engineering. Except for some of the testimony of some of the social scientists themselves, to be mentioned later, most of the discussion on the part of physical scientists makes it clear that they think of social science entirely in terms of its relation to health, medicine, stream pollution, improvement of standards of living, improvement in public assistance, the care of orphans, and its significance in "raising the general level of humanity" and doing good in general. Such a program, in addition to a lot of general education, presumably of essentially the same sort that is now being dispensed, is probably what most people understand by social science.

The "applied" nature of social science research was urged both in opposition to, and in support of, the inclusion of the social sciences in the National Research Foundation. As an example in opposition, the following remark of Dr. Morris Fishbein, on behalf of the American Medical Association, is significant:

> DR. FISHBEIN: We doubt the desirability of entering at this time into research on the social sciences, and I will mention the chief reason for that, which is the great danger of the use of so-called research in the social sciences for political purposes and to influence legislation (496).

Other examples of opposition on the ground that the social sciences are "applied" will appear in the next section. On the other hand, much of the data cited by the social scientists themselves in support of the social sciences were of the "applied" type. This was also true of the testimony of some prominent government officials.

3. *Social science research should be controlled by a separate foundation.* Closely related to the above views, and more or less in consequence of them, was the view that, while research in the social sciences should be supported, the activity should be controlled by a separate foundation.

A good deal of the testimony of the physical scientists took this form. For example, Dr. I. I. Rabi, of the Columbia Radiation Laboratories, and Senator Fulbright engaged in the following discussion:

> DR. RABI: It seems to me that social sciences certainly need support, but it also seems to me that it would be wrong to tie it in with the physical sciences. Although they are both called sciences, their disciplines are actually very different, the type of training. One is certainly more controversial than the other, and I would say that it would need an entirely different kind of board, a different kind of administrator. I think that hitching them together in this way would harm both.
>
> SENATOR FULBRIGHT: If social science was made a separate division, they are not mixed up, that was discussed the other day. I didn't mean to put social scientists out in all the divisions which are concerned with natural science, but make a separate division. Would that still be subject to an objection?
>
> DR. RABI: I still think so. For example, most of the things or many of the things which a social scientist has to say are controversial in nature. It is not generally possible for them to prove a point by direct experiment and so on. I think hitching these two together you might find under certain political complexion of this country that the work of the social science would become unpopular and would therefore reflect on the whole job. It seems

to me that the two fields are sufficiently different that one wouldn't quite do that. It would not be wise to have them sink or swim together (998).

It is impossible to blame these scientists for their desire to avoid compromising their own sciences because of the character of much that is today offered to the public as social science. It is to be noted, too, that the remarks of the physical scientists are directed at the social sciences as they are today rather than making the broader assumptions that these weaknesses are intrinsic and inherent in social phenomena. Nevertheless, their testimony was probably extremely influential in crystalizing this view which was most conspicuously urged on the Senate floor against the inclusion of the social sciences. Dr. Rabi also raised one additional point regarding the danger of government control of social research which is worth mentioning:

Dr. Rabi: I have one other objection to its inclusion, if I may say so, Senator. That is, I am afraid of the power of this foundation, in the support of social sciences through fellowships and otherwise, to make such selections as to strengthen a preconceived point of view or a particular opinion. You see, social science comes very closely to the fundamental political question which are questions of the day, and I begin to see possibility of a Government's building up a certain body of opinion, a certain direction of thinking through that, whereas in the physical sciences I am not afraid of that simply because it is quite objective. You can prove things by experiment (999).

A similar viewpoint was common among the engineers. For example, Thorndike Saville, Dean of Engineering, New York University, speaking for 67 of the principal engineering colleges of the country, testified as follows:

Dr. Saville: By no means deprecating the importance of the social sciences, we believe that they merit separate support for research and should not be included in the present proposal. In view of the importance of the social sciences we believe that our association will support a separate bill to that end. Such separation would be of greater over-all good to the public; in other words, the two fields of physical and social science do not belong together in the scope of the agency it is proposed to set up (707).

This view of the matter is strongly emphasized also in the testimony of Dr. B. A. Bakhmeteff speaking as a member of a committee from five major national engineering societies:

Dr. Bakhmeteff: Now the natural sciences, of course, deal with the immutable laws of nature and politics doesn't enter into that. The social sciences, of course, on the contrary, deal with changing relations between men and you can't help in appointing for example, members of a board which is going to deal with social sciences, to find there is going to be a lot of pressure from pressure groups, and so on, and it must be an entirely different type of men who administer the one and the other, and our idea would be this: We think that a social-science group, and a science group or a basic research group, will benefit tremendously by mutual contact, and I think that each can teach the other one something, but we feel that the purpose of your legislation will be better served if they are kept under different roofs and not fused together (715).

The same note appears in the testimony of Dr. Harlow Shapley who, again, was friendly to the social sciences but somewhat worried as to just how to provide for them:

Dr. Shapley: The scientists who worked on the various committees that produced the Bush report were acting under a directive from President Roosevelt, that they look into the field of science. That was interpreted as the natural sciences and, therefore, as a matter of course, the social sciences were not included in the report, nor in the resulting proposal for legislation. Nevertheless, the natural scientists, in thinking the problem over, seemed to me to have become increasingly aware of the necessity of including at an early date, as I suggested, at least some of the social sciences. . . . There has been some worry among the social scientists, I would say, as well as among legislators and natural scientists, that the social scientists have to deal with subjects that are close to politics at times and, therefore, there might be a bit of confusion in a clear-cut bill in the support of science if they were too generously or too clearly brought into the picture . . . statistics

and, I'd say, anthropology and studies of population migrations and all such problems are of immediate concern. If they could be included in this bill, I would heartily endorse such inclusion personally, but I speak only as an individual, not for any group (51–52).

Most significant of all in this connection, perhaps, was the testimony of Karl T. Compton, of M.I.T. It is doubly significant that Senator Smith, of New Jersey (who opposed the bill in the Senate), was present during Dr. Compton's testimony. The following type of discussion may have had great indirect significance in determining the ultimate action on the bill:

SENATOR SMITH: In your mind does this foundation for scientific research include anything but the strictly scientific? Would you take the social sciences and humanistics, etc., or should they be left outside the field of Federal support?

DR. COMPTON: That is a problem I have worried about a good deal, and I am not sure I can give a sensible answer. Theoretically, I think it would be fine to include the social sciences; practically, I don't know where you would stop, because everything is social science, really, everything that human beings are interested in. One difficulty that I see in trying to combine the two in one foundation is the fact that methods are so different, I think if they were combined in one foundation it would probably be necessary to do what is in fact contemplated in the bill—that is, have two divisions, one which specialized on one, and one on the other. That is the way some of the big foundations operate.

SENATOR SMITH: I might say I just read a report that Dr. Dodd of Princeton had submitted on the subject. He rather thinks you can't bring the social and humanistic sciences into this picture. This is strictly on the scientific end of the page.

DR. COMPTON: It would certainly be a lot easier to handle and I think it would be handled more effectively if they were not brought in, but I don't want to say the social sciences don't need help. They have some terrific problems, but I am not sure in my own mind whether this is the best way to help them or not (631).

Later, in connection with the same colloquy, Dr. Compton testified as follows:

DR. COMPTON: It seems to me that the impact of the social sciences comes in under a very much bigger umbrella than a foundation of this sort. Everything in public opinion and the press brings about that impact. I don't think the additional gain that would come here would be very great. Also, *I am somewhat suspicious of any group trying to set out a program of discovery of the facts of nature, as far as the fundamental science is concerned, on the basis of an anticipated exploitation or intensification of one or another social objective* (631) [italics mine].

So far as the fundamental research is concerned, I don't believe the presence of the social scientist would be helpful and it would be better to have more of the natural science on there. When it comes to any stimulation of applied research, things that might be of benefit to the community, then I think the social scientist could be useful. I haven't given you a clear-cut answer, because I don't have a clear-cut decision in my own mind (632).

There is no doubt that Dr. Compton in the passage italicized has put his finger on a point on which a large proportion of social scientists are guilty, and which many, in fact, regard as their proper business. The implication of this statement is undoubtedly the most damaging one that at present lies at the door of social scientists.

The contention that the social sciences must be supported, but under a separate foundation, doubtless seemed reasonable to many Senators in view of the characteristics that had been imputed, not without justice, to these sciences as currently defined and practiced. Actually, however, the proposal to provide separately for the social sciences is open to two serious objections: (1) It would only tend to perpetuate the present unfortunate gap between the physical and the social sciences and thereby foster the very shortcomings of the latter which are today urged as the reasons for not including them with the physical sciences in the same foundation. (2) One of the principal arguments for the separation was the present undefined scope and content of the social sciences, which, as Senator Hart suggested, at present may

include "perhaps religion" and "various kinds of ideology." To others the term includes the even more amorphous area commonly called the "humanities." The possibility of any kind of effective social science research being carried on under an organization devoted to such incongruous methods seems extremely remote.

Inclusion of the social sciences would, of course, have required at the outset a more rigorous definition of these fields. Such definition could easily and defensibly have been arrived at on the basis of scientific criteria acceptable to scientists. President Conant, who is himself a chemist and, perhaps with good reason, not disposed to take the social sciences too seriously, nevertheless urged the inclusion of psychology, anthropology, sociology, and economics.

In this connection the following exchange ensued:

Senator Fulbright: I don't believe you mentioned political sciences. That is sort of vague.

Dr. Conant: That is why I didn't mention it.

Senator Fulbright: That is really the greatest weakness of our democracy.

Dr. Conant: Yes; the difficulty is whether your immediate advances in that wouldn't come through the role of sociology, anthropology, and psychology.

Senator Fulbright: I confess I don't quite know how to approach it except through general education . . . (984).

The contention that the same officials qualified to administer a foundation devoted to physical and biological science would not be qualified to administer also an organization including the social sciences seems to me totally without merit. In fact, it might be a healthy thing for social scientists to be compelled to satisfy an administrative board composed largely of physical scientists both as regards the "basic" nature of proposed social research, as well as its freedom from "ideological" taint. To break down the traditional separation of the physical and the social sciences is precisely what is needed in the present situation and an end to which the National Science Foundation might have contributed.

4. *Education rather than research is needed in the social sciences.* There recurs throughout the hearings the idea that so far as social problems are concerned what is needed is education rather than research. The curious notion continues to persist that education is a panacea for all social problems, no matter what kind of education it is and no matter how erroneous the notions inculcated through education may be. Thus Senator Fulbright repeatedly comes back to the point that the present social situation requires primarily education and political measures, although he is also a strong supporter of research. In connection with some of Professor Ogburn's testimony, Senator Fulbright said:

Senator Fulbright: . . . The educational system from the beginning up, I think, is frankly very poor in this country. It hasn't kept up with our material problems, and I think one of the difficulties goes right back to our elementary schools. People simply don't appreciate the significance of social sciences, which means your legislators don't either. I mean they reflect the people's reaction. That is the great trouble. I have been bothered about it a great deal . . . . I don't think that is an argument against doing this research, but it seems to me that one of the troubles of getting research is the poor level of the education of the people as a whole in this country. They can appreciate an automobile or a bathtub, but it is exceedingly difficult to get support, public support, for programs in this field, which I confess I think is our greatest weakness as a nation (780).

It is impossible, of course, to disagree with this statement of Senator Fulbright, although he seems to have become involved here in the old hen-egg problem in his feeling that the reason it is difficult to get support for social research is the low level of education, and the low level of education may in turn be regarded as the result of the failure on the part of the social sciences to demonstrate the importance of education

in these sciences. Actually, of course, the two must go forward together. This they have not done, especially in the social sciences, for the reason earlier mentioned, namely, that there is a widespread feeling that we know the answers to social problems and that therefore no research is needed. The feeling seems to be that all we need to do is to diffuse what we already know sufficiently widely and fervently. The proportion of university budgets devoted to teaching and to research, especially in the social sciences, reflects this attitude. Education has become a fetish. It is something which no one dares to question and for which enormous sums are available. The idea that the importance of education depends on the validity and relevance of what is taught has made little headway to date.

In this connection, Dr. Smyth, of Princeton, testified as follows:

> DR. SMYTH: I think possibly it is desirable to have at least scholarships and fellowships in the social sciences. I am more skeptical about attempting to set up in this bill a division of research in the social sciences, because, to my mind, it is very hard to limit it. I am not a social scientist, but, as Dr. Compton said, it is very hard to say what shouldn't come under that, whereas it is fairly easy to define what you mean by research activity in the physical sciences. But, in line with my general idea that what you need is to get more people well educated, is the basis for scientific progress and every other kind of progress, and I would be glad to see scholarships established in the social sciences. I think they might be related with those in the natural sciences (652–653).

In the latter connection Dr. Smyth went on to say:

> DR. SMYTH: Let me say this: I believe that our great problem—I am sure this is obvious to everyone—our great problems that we face are not the problems of the natural sciences, they are the problems of the social sciences, and of politics and of ethics, if you like. If it were possible to do, I think conceivably the best thing for the world would be to retire all the natural scientists, pension them off in pleasant places, or else put them to work on social-science problems—at least stop their research until the world caught up with them in a sense (654).
>
> THE CHAIRMAN [SENATOR KILGORE]: No. You must keep ahead with your basic sciences. You must keep ahead with the basic inquiry into the laws of nature, so that you know what law to employ when a social scientific problem comes up or how to modify that law to meet the problem (654).

The Chairman is apparently here under the impression that the laws of nature are necessarily confined to the physical sciences and that the problems of social science are themselves to be solved ultimately, if at all, by applying some law of the physical sciences.

We have already referred to this question above. The testimony of the social scientists who appeared before the Committee, although they made able and convincing statements of their case, probably did little to resolve the fundamental confusion which persists in the minds of most scientists to the effect that the social sciences cannot be basic. Indeed, there is little reason to believe that the result could have been altered even if this highly pertinent testimony had been eloquently presented on the Senate floor, in view of the tremendous dead weight of traditional views on this subject as revealed in all the testimony and the debate. Excellent statements and discussion on behalf of the social sciences were submitted by Wesley C. Mitchell, John M. Gaus, Robert M. Yerkes, E. G. Nourse, W. F. Ogburn, and E. E. Day. Dr. Gaus spoke specifically and ably in refutation of the point that the social sciences are "suspected of being largely the recording of partisan and prejudiced attitudes already present when the research was undertaken." Dr. Yerkes emphasized that "we are weakest at the present moment on the basic or relatively disinterested sort of inquiry."

Dr. Ogburn devoted some much needed attention to the vast confusion revealed in

the hearings regarding the relationship between social science and ethics. As Professor Ogburn correctly pointed out, it is not the province of the scientist to say whether the substance he makes shall be used for spraying fruit trees or for killing human beings:

Dr. Ogburn: He can say that as a human being if he wishes to, but his science begins with making the product and making the gas and stops there. He may choose as a hypothesis to work on a poison gas which will kill insects, and he does that, it seems to me, on a value basis. Social sciences were greatly confused by the mixing in of values with the consideration of knowledge. I think if that distinction is kept clear, the role of the social scientist is seen very much better (769).

This point of view was reinforced by Monsignor John M. Cooper, Professor of Anthropology, Catholic University, in the following words:

Father Cooper: Although anthropologists, like their confreres in the social and other sciences, are more or less agreed on the philosophical assumption of the dignity and value of the human personality, they do not in the name of their science sponsor any specific philosophy of life . . . (778).

The Reverend J. Hugh O'Donnell, President of the University of Notre Dame, on the other hand, was worried about the threat which federal subsidy might constitute to the independence of higher education. He said he would have no objection to the inclusion of social sciences, provided that "any kind of agency that is established for social sciences be conducted by capable social scientists who have a philosophy that is basic, with a recognition of certain fundamental truths as they relate to society" (454).

5. *The atomic bomb should frighten people into effective social organization.* Closely related to the belief in education as of itself a solution to social problems was the recurrent idea before the hearings that, if the horrors of the atomic bomb could only be brought home sufficiently vividly to every hamlet and family, the solution of social problems, especially international problems, would somehow mysteriously be resolved. This appears to be merely another aspect of the same misapprehension that causes people to believe that the severity of punishment will prevent crime, although we know that when pickpockets were punished with death, other pickpockets operated extensively in the crowds that came to attend executions. The same erroneous assumption now finds expression in the notion that successful international organization will come about somehow by merely convincing enough people of the *need* for such organization. It is hardly necessary to point out that the epidemics that have swept over the human race have frequently been sufficiently terrifying to cause nearly everyone to go about in imminent fear of his life. People were certainly convinced of the need and the desirability of a remedy. Yet the need and the fear could not possibly have produced sulfa drugs except as the felt need actually found expression in scientific research. The following colloquy between Dr. Rabi and Senator Fulbright appears to proceed quite confidently on the opposite assumption. Dr. Rabi had just emphasized that to be fully impressed with the results of the atomic bomb one must see firsthand its actual consequences.

Dr. Rabi: It's like death. One doesn't really believe it until after it happens. . . . I think young people are not afraid of death because it is far off and no close member of the family and so on has died. After they have had some experience with that, then they feel differently. I think it is this very thing and I think it is as fundamental as that. Therefore I believe that actual demonstrations in some form that would bring the immediacy of the problem to the American people first of all and to the people of the world afterward, would lead to a real solution. In other words, they would get to a state of mind where they would not be satisfied with half-way measures. They would want to make sure that they

are not going to see this thing coming at them.

SENATOR FULBRIGHT: I certainly subscribe to that, but I am still puzzled as to how to do it, how to carry it into effect, how to do the demonstration and the mechanics of it.

DR. RABI: Oh, the Army could arrange that.

SENATOR FULBRIGHT: You think the Army could arrange that?

DR. RABI: Oh, sure, beautifully.

SENATOR FULBRIGHT: I shouldn't think a demonstration on the water would have that effect at all because it is too removed from the every day experiences of most people. I would think it should be as nearly like a city, like Kansas City or New York. Have you ever discussed this with the Army or with anyone? Are they contemplating any such demonstration, do you know?

DR. RABI: I haven't discussed this with the Army (996).

The reasoning seems to be that some of us are sure we know what the remedy is and that all that is needed is to shock enough people so as to agree with us. The idea that preventing war, and relieving the tensions that lead to war, might be technically as involved and difficult a problem as those that have to do with the development and the application of a comprehensive system of vaccination or a program of public health seems to have occurred to no one.

The only note of skepticism about this and other matters occurs in the testimony of Dr. L. Don Leet, of Harvard University, who was also connected with the production of the atomic bomb. Senator Fulbright had remarked that the real purpose of discussing the possibilities of the atomic bomb is to dramatize the effect which few people, he feels, fully appreciate:

DR. LEET: Yes; I feel that a larger percentage of the people are impressed than maybe you realize. You can talk to anyone on the street, and the first dozen words will bring the atomic bomb into consideration, and he turns pale.

SENATOR FULBRIGHT: Perhaps people are, but I see very few signs of anything effective being done about it in the international political field. That is the only thing that is important. If you have a few people on the street thinking it is a bad thing, it doesn't help any unless some action is taken in the political endeavor. Eventually that action is taken as the result of pressure from people in most cases. That is why it is important (1025).

Incidentally, Dr. Leet was the only physicist who suggested that perhaps the assumed effects of the atomic bomb had been somewhat exaggerated. But the general sentiment in the hearings was that if only enough people, and especially the physical scientists, would publicize their views as to the destructiveness of the bomb, much good would come of it. Thus, Dr. Harry Grundfest, Secretary, American Association of Scientific Workers, expressed great hopefulness over the fact that many scientists have finally become politically active for the first time. He mentioned that under the sponsorship of his Association a statement was signed in Philadelphia by more than 600 people.

DR. GRUNDFEST: It has grown even larger than that. Within a week and a half—the last report I had was on Wednesday—they had already had 800 signatures, and probably by now it is well over a thousand. The same thing is going on in Boston—over 500 people subscribed to a statement, essentially the same sort of thing, that you cannot keep this a secret; that you must have some form of international control . . . (1,028).

It is only fair to note that on the general subject of physicists' current advice on social organization, Dr. Oppenheimer had previously injected a word of caution. Commenting on the prepared statement of Dr. H. J. Curtis, of the Association of Oak Ridge Scientists of Clinton Laboratories, who was also prominent in the production of the atomic bomb, Dr. Oppenheimer made the following remark regarding the possible contribution of prominent physicists to the solution of social and political problems:

DR. OPPENHEIMER: But that contribution cannot be made by underestimating the difficulties, and I think the prepared statement which you read gives

an impression of political naivete on the part of the scientists which I would not like to see given, though it may correspond to the facts (328).

We have reviewed above the considerations that were urged against the inclusion of the social sciences in a comprehensive program of research in basic science as contemplated by the National Science Foundation. These views are significant because they are sincerely held by people of prominence and influence in science, education, and public affairs. A rough measure of the present status of the social sciences in the estimation of these people may, therefore, be secured from the statements reviewed.

Briefly, these views may be summarized as follows: (1) Man and his behavior are not a part of nature that can be studied as basic, "pure," natural science; the social sciences are inherently "applied" and concerned with ameliorative and exploitive techniques in the service of whatever tribal lore happens to be current. Social science, therefore, is a nondescript category consisting mainly of reformist and propagandist ideologies and isms. (2) The methods of the social sciences are so widely at variance with those of other sciences as to make it inadvisable to attempt to administer research in the social sciences under the same organization (*a*) for fear of discrediting the other sciences and (*b*) because people qualified to direct research in the other sciences would not be able to judge what constitutes valid or desirable social research. (3) Social research is especially in danger of falling a victim to pressure groups or of being corrupted by the government itself.[4] And, finally, (4) there is always in the background of the testimony reviewed, the traditional view that, after all, we know the solution of social problems through the historic pronouncements of seers and sages, past and contemporary, and all that is needed is more education to diffuse this lore and arouse moral fervor in its behalf. In connection with the last point, there is currently a widespread belief that if we only frighten people badly enough with the atomic bomb, they will forthwith become so changed in their nature and behavior as to insure the elimination of war.

The last of the above considerations is especially revealing regarding what is undoubtedly the dominant attitude at present as to the approach to social problems. It is a traditional position, the surviving supporters of which vaguely call themselves "humanists." At least one of their spokesmen frankly advocated that the notion of including social science in the National Science Foundation should be abandoned, and that instead a "humanities" division should be created, which specifically "would not engage in research" but rather "stir concern . . . for teaching . . . the accumulated wisdom of our civilization." In short, although research and the advancement of science have been the principal conditions for the improvement of our adjustments to the physical world, we already know the answers to social problems, or at least can find these answers by simply consulting seers and sages of ancient and contemporary times, including poets, playwrights, novelists, newspaper columnists, and radio commentators. This whole attitude and approach represents a far greater menace to civilization than does the atomic bomb. For the assumption that we know the answers to the basic sociological questions and that the latter are not amenable to scientific research, closes the door against the only approach, other than blundering trial and error, which can possibly avail.

The state of mind reviewed in this paper will indicate to social scientists the task before them:

(1) In the first place, if social scientists

aspire to the status and position and public estimation of other scientists, they must subject themselves to standards of the kind recognized by other scientists and by the public. That is, they must specify criteria that distinguish social scientists from that vast array of camp followers, reformers, propagandists, and social workers, which today dominate even most of the professional organizations of social scientists. The first step in this process is for social and other scientists themselves to make up their minds regarding the proper function of scientists as contrasted with the functions of citizens. Large numbers of both physical and social scientists are today not at all clear on that point. Many of them are firmly convinced that it is the peculiar function of social scientists especially, not only to describe reliably the costs and consequences of alternative courses of action, but also to dictate public policy. Indeed, this group is not infrequently scornful of the scientist who scrupulously distinguishes his scientific role from other interests which occupy him. They fondly imagine themselves to be the chief defenders of science. The hearings and the debate on the bill to establish a National Science Foundation clearly brought out that they are actually the worst enemies of the social sciences at the present time because it is precisely this failure on the part of social scientists to recognize their proper function as scientists which caused most of the objection to the inclusion of these sciences in the National Science Foundation. This objection must be recognized as a valid one, and the responsibility for the situation lies squarely at the door of social scientists themselves, who have been careless of their scientific reputation in a number of ways: Through lack of clarity or lack of intellectual integrity they have failed to make clear to the public when they have spoken as scientists and when they have spoken as propagandists and as citizens. They have posed as social scientists, and frequently claimed academic immunity as such, while actually engaging in ordinary pressure group activity. Finally, they have been careless in distinguishing between scientific research and special pleading.

(2) In the second place, social scientists must submit examples of research that are recognized as scientific research by other scientists. This they are in a position to do to an increasing degree.[5] The worry revealed in the hearings about the possible incapacity of physical scientists as administrators of a research foundation properly to appreciate and judge social research seems to me largely unfounded. On the contrary, I am satisfied that really scientific social research has a better chance for promotion under such administration than under a board composed largely of historians and humanists of the type whose testimony has been reviewed above and who not infrequently dominate the social research wings of important private foundations.

(3) In the third place, and incidentally, Section K of the A.A.A.S. should aim more strictly than at present to represent social science as science and to avoid giving grounds for the sort of criticism revealed in the hearings. It may be that the Association should have a section devoted to Ethics, Planning, and Social Policy and thus avoid the confusion which results from including these topics with the social sciences.

(4) Finally, education from the grades upward must be revised in the direction of a more comprehensive and thorough teaching of the nature of scientific method. There is ample evidence that in spite of the lip service to science and the increasingly dominating role which science plays in our time, no considerable proportion of the

population which goes through our present schools gains any adequate grasp whatever as to the nature of the method that is science. A recent investigation at the University of Iowa[6] revealed that the activity we call research is not well understood either by community leaders or by the students coming up through our schools; that research is not considered as an important function in society; and that research is not looked upon as an important method of solving social problems. Our proper concern with the importance of education and literacy has caused us to neglect the equally important consideration of the development of knowledge worth communicating through education. The importance of education must be measured not only by its extent, but by its *validity* and its *relevance* to the problems for which it is supposed to be a help. There is every evidence that much of present education is both invalid and irrelevant.[7]

Proposals to establish a National Science Foundation having again come before Congress, the above review should indicate the principal obstacles which they may encounter.

NOTES

1. *Hearings Before a Subcommittee of the Committee on Military Affairs*, U. S. Senate, 79th Congress, first session, Parts I–IV. Numbers in parentheses following quotations refer to pages in this report or in the *Congressional Record*.
2. The vote on Senator Hart's amendment to exclude the social sciences was 46 to 26. It was announced that had certain absent senators been present this vote would have been 47 to 29. The attitude of the additional 20 absent senators is not known. The following senators voted against Hart's amendment and therefore in favor of including the social sciences: Aiken, Barkley, Chaney, Downey, Ferguson, Guffey, Hayden, Hill, Kilgore, La Follette, Langer, Lucas, McCarran, Magnuson, Mitchell, Morse, Murdock, Murray, Myers, O'Mahoney, Pepper, Radcliffe, Taylor, Thomas, Tunnell, Wagner. The following absent senators were also announced as favoring the inclusion of the social sciences: Mead, Green, Fulbright.
3. For a brief popular exposition see Lundberg, Geo. A. Can Science Save Us? *Harper's*, December 1945. Also a book by the same title, Longmans, Green, 1947. For a more thorough discussion, the following books by the same author give the basic argument as well as extensive references to the supporting literature, including references to recent relevant research: *Foundations of Sociology*, Macmillan, 1939; *Social Research*, Longmans, Green, 2nd Ed., 1942. See also Lundberg, G. A. The Growth of Scientific Method. *Amer. J. Soc.*, May 1945.
4. I have considered this question in my paper, The Social Sciences in the Post-War Era. *Sociometry*, **8**, 137–149, 1945.
5. For a review of some such research, see Lundberg, G. A. The Growth of Scientific Method. *Amer. J. Soc.*, **50**, 502–513, 1945.
6. Ojemann, R. H. The Cultural Understanding and Appreciation of the Scientific Approach. *Science*, **104**, 335–338, 1946. For a brilliant analysis of the failure of education to equip people with even elementary realism about social organization, see Pelcovitz, N. A. World Government Now? *Harper's*, November 1946.
7. For specific suggestions for the revision of educational curricula, see Lundberg, G. A. What to Do With the Humanities. *Harper's*, June 1943.

THE UNIVERSITY PRESSES:

THEIR FUNCTION

By ROLLIN D. HEMENS

The University of Chicago Press

AN ever-increasing number of persons are becoming aware that there is such an organization as a university press. This is due, in part, to the increase in the number of university presses—they have about doubled in recent years. More than that, the university press is now doing a professional job of publishing. The result is an increase in review attention, better and more extensive advertising, and a substantial growth in the number of people reading university press books. In spite of this, however, a vast majority do not know what a university press is and what it is supposed to do.

Frequently someone will say: "The University Press? Oh, yes, you publish the student daily paper and the alumni magazine." Others will begin talking about the technical problems of printing and of running a printing plant. One business executive indicated that he thought a university press was some kind of a machine punch-press operation connected with a school of engineering. Fortunately, most scientists think of the university press as the publishing organization that it is. Some scientists have definite ideas as to what a press should publish and are known to have alluded to a particular title as "a typical university press book." However, there is no generally accepted definition of this "typical" book. Usually it is referred to as sound—I suspect that the person really means "dull"—a book which will have a limited sale. One person recently answered the question in this manner: "It is a book which has been well handled; by that I mean well edited, well indexed, and well printed." He made no reference to subject matter, footnotes—or sales.

If we examine the activities of the presses to get an answer to the question, What is the function of a university press? we are likely to become confused. There are, roughly, sixty university presses in the United States and Canada. Many of them are small, their sole operation consisting of the printing of college announcements, class schedules, stationery, and such material. Others regularly publish books and magazines, which are produced in large and well-equipped printing plants owned by the same press. Still other university presses limit their activities to publishing; they do not operate a printing plant.

Thirty-four of these are members of the Association of American University Presses. Each publishes five or more books a year, and some also issue scholarly journals. A few of these presses have their own printing plants which do book work; Harvard, California, Stanford, and Princeton are examples. Others, like Columbia, North Carolina, and Minnesota, have all their printing done by commercial houses. Publication of books is the common characteristic of these thirty-four members of the Association.

An examination of the catalogues of these university presses in the hope of finding common characteristics which will help define their functions and indicate basic differences between them and commercial publishers proves disappointing. On Harvard's list will be found Chinese dictionaries and on Chicago's *A Dictionary of American English* and Smith-Goodspeed: *The Bible: An American Translation*. Yale has a series in poetry; Columbia, a one-volume encyclopedia; North Carolina and Princeton, fiction; and New Mexico, juveniles. There is

a large variety on each list, but in total there are college, elementary-, and high-school textbooks, medical books, Bibles, encyclopedias, art books, poetry, fiction, books on architecture, politics, literature, and so on through the entire gamut of publishing.

A scanning of the list of authors is not much more helpful. It is true, of course, that university professors are the largest single group represented. But there are, in addition, professional writers, businessmen, men and women in government service, lawyers, and others. This again exhibits a marked similarity to commercial publishing houses.

If there is so much similarity, you may ask, between the university press and the commercial house—if the books published and the authors who write them are essentially the same—what is the unique function of the university press? How does it differ from the commercial house?

First, a university press is a nonprofit organization. It is either a department of, or a separate corporation wholly controlled by, the university whose name it bears. Its objective is education rather than profit. To be sure, many university press books are profitable, and some are selected because they are expected to yield a profit. Frequently a university press will seek profitable titles as a regular part of its annual publishing program. The surplus income is then used to subsidize important but unprofitable books and journals. Presumably, manuscripts which are expected to yield a profit are checked as carefully as the unprofitable ones to make certain that they are scholarly, competent, and a new contribution to human knowledge.

Second, the university press disseminates the results of scholarship and science. The sole purpose of the early university presses in this country was to complete the research of scholars and scientists. At the time, the universities found that, after spending thousands of dollars on research, there existed no adequate means of making the results available to more than a few of the scholar's personal acquaintances. It was difficult and time-consuming for a Harvard astronomer to know what a Chicago colleague was doing in the same field. It was virtually years before there was exchange of information between continents. Therefore, the university press was established to perform that final step of research and scholarship—publication.

Books in the category of scholarly writing are not necessarily limited to titles such as *The Genitive of Value in Latin and Other Constructions with Verbs of Rating* or *An Attempt To Frame a Working Hypothesis of the Cause of Glacial Periods on an Atmospheric Basis*. Nor are all titles as specialized as *A Reverse Index of Greek Nouns and Adjectives* or *A Study of the Spectra of 7e Aurigae*. Another type of scholarly work is represented by *A Dictionary of American English on Historical Principles* compiled under the editorship of Sir William Craigie. It is a monumental work planned for scholars. In preparing the *Dictionary*, the editors attempted to collect, select, and present "all that is really significant for the history of the American language," and it will be a steppingstone for research for many years. Moreover, the *Dictionary* has already proved its usefulness to writers in all fields. It reveals, for example, that the word "lumberman," meaning a man engaged in the lumbering business, was first used in American speech in 1817; therefore, it would be an anachronism in an authentic play of an earlier date.

Daring teachers frequently break with tradition and in their respective subjects develop methods of teaching which they believe better adapted to the needs of today's student. Often their ideas should be made available in book form for study and experiment elsewhere. Occasionally, the materials used for teaching should be

published, presumably, at first, in experimental editions. The New Plan of the College of the University of Chicago several years ago—and the series of New Plan textbooks in the physical sciences and in the biological sciences—is an example of this type of experiment which results in publication of new textbooks. The objective of the courses was to give all students, regardless of their intended specialization, a general introduction to the natural sciences. In developing the courses, the faculty discovered that textbooks for the traditional course were wholly unsuited for their use. Therefore, they prepared new books—and in some cases integrated sound motion pictures with them. There are good reasons why this experimental publishing is not undertaken by the commercial house but left to the university press. In the case of the New Plan textbooks, for example, there was no assurance that the books would be used elsewhere—or, for that matter, very long at Chicago. The investment in production was large, and the sales problems were unique. In this instance the experiment was so successful that the books are used in many of our colleges and universities. Some of the titles have been translated into Spanish or Portuguese or both, and one has been republished in Australia. Trade editions of several of the titles, moreover, have had a satisfactory sale to the general public.

Third, the university presses are pioneering in the field of adult education. Thus, publication for the academic and scholarly market is no longer the sole interest of many of them. Along with most universities, the presses have become interested in adult education. More and more, they are undertaking to select manuscripts which tell the lay reader what the research worker is finding in the many fields of knowledge. Because this activity is new to university presses, they are doing it less well than they are the publishing of scholarly books and journals. In addition, there appears to me to be some confusion as to objectives. A few of the presses have not undertaken the publication of any books in adult education; others have gone into the open market for authors and subjects which are thought to stand a good chance of being a Book-of-the-Month Club selection or of getting on the *New York Times* or *New York Herald Tribune* best-seller list.

There is nothing wrong about a university press book being selected by the Book-of-the-Month Club or the Literary Guild, or being on a list of best sellers. The recent selection of Paul Angle's *Lincoln Reader*, published by the Rutgers University Press, illustrates this quite well. However, in selecting manuscripts with both eyes on possible book-club selection, the university press enters directly into a field in which the commercial publisher has the advantage in experience and resources. But, more important, the university press, in so doing, turns its back on the opportunities and the responsibilities which are peculiarly its own.

As a nonprofit organization, bearing the name of a university, the press has a first responsibility to contribute to education and human knowledge. To do this it has access to the total resources of the university—resources not so readily available to commercial publishers. Almost every campus is a storehouse of jewels, most of them in the rough or buried deep in the dust of academic verbiage and "stuffed-shirtage." The director of a university press has a rare opportunity of easy access to this storehouse. Each jewel he unearths will need cutting and polishing. Some will be for the crown of science; others will be for the laborer's tool or for the immigrant's understanding of American life. Many will be found to have blemishes, and others may be chipped, but in the lot will be more than one stone of exceptional value.

The university presses have much to learn before they can be successful in pub-

lishing books informing any large section of the American public about the discoveries and research on university campuses. The subject matter of most of their trade books—that is, books expected to be sold through bookstores to the general public—is interesting and, many times, exciting. However, most of the titles sell only a few thousand copies. A sale of fifty thousand copies is considered exceptionally good; and a hundred thousand, stupendous. But these sales barely scratch the surface of the nonfiction reading public represented by the colossal weekly sale of such magazines as *Time, Life, Newsweek*, etc., and the monthly sale of *Reader's Digest*.

The problem of the university press is to reach that large group of our population which is intensely interested in knowing what is being thought and discovered on university campuses. The farmer, the mechanic, the saleswoman, the factory worker, the milkman, all want to keep abreast of advanced thinking. But each of them is too tired at day's end to read with a book in one hand, a dictionary in the other, and an encyclopedia in front of him. Advertisers and motion-picture and radio producers are acutely aware of this and take it into account when making their presentations. As a result, they undoubtedly have greater direct influence on the thinking of the mass population than do all the books ever published by all our university presses.

Fourth, the publishing of experimental or exploratory subject matter has long been considered a function of our university presses. I hope that someday one of them will have the imagination, the money, and the fortitude to forget tradition in preparing its books for the public. The University of Chicago Press went part way some years ago when it published *Animals without Backbones*, by Ralph Buchsbaum, and *From Galileo to Cosmic Rays*, by Harvey B. Lemon. But, on the whole, the presses hold to tradition—a tradition which gives first consideration to conformity to conventional patterns of bookmaking. If the lead of other industries were followed, the manuscripts would be considered as a collection of ideas. All modern techniques of style, illustration, typography, layout, color, and the like would be adapted to making the best possible package for delivering the ideas to the people to whom they are addressed. Such a program would likely mean adding to the staff of each press a person trained in the technique of advertising illustration and layout and a person, possibly a newspaper writer or an advertising copywriter, trained in writing for the lay reader. These persons would work with the publisher's regular editor, designer, and layout man in determining the design, style, illustration, and text best suited for presenting the author's ideas.

There are many other conceptions of the function of the university press. Some persons think of it as principally a publicity agency for the university; some believe that it should publish books to be distributed free by the author or by the college library; others feel that it should issue the writing of any faculty member provided he pays the cost of publication. This may be so. But it is my belief that the first responsibility of a university press is publication of scholarly writing for the advancement of scholarship and science. This publication would include books and magazines and textbooks as well as monographs. A further function would be the publication of books of inherent excellence which present the findings and thoughts of scholars for the education of the lay, or nonprofessional, reader. Another objective would be the maintenance of an attitude of experimentation and exploration in order that the presses may advance the frontiers of publishing as the scientists advance those of learning.

THE UNIVERSITY PRESSES
AND THE POPULARIZATION OF SCIENCE

By HERBERT S. BAILEY, JR.

Princeton University Press

A DISTINGUISHED mathematician recently told me that when he received a prize for his "Investigations in Hilbert Space," a newspaper reporter came to interview him. The mathematician obligingly received the reporter and patiently explained to him in simple terms what Hilbert space is. When he had finished, the reporter asked, "Does this mean, sir, that you do not believe in God?"

This extreme case explains clearly why scientists are so reluctant to talk to reporters. Newspapermen often will not take a "straight" story and print it; they must have an "angle"—something sensational. And the scientist who permits an interview is amazed to see in the morning headlines:

MATH WIZARD PROVES ATHEISM

A scientist who has the uncomfortable experience of being probed for sensational statements and of seeing his words twisted in the published report is likely to return to his laboratory vowing never to submit to an interview again. He will stick to his scalpel or his test tubes or his cyclotron; and the public, though it may receive the *material* results of his work, will not for a long time have the benefit of the *ideas* that he produces.

If the scientist does this, he is neglecting an important responsibility to society, for there is a real urge among the educated public to know the advances of science, and there is a real need for them to know. In the long run, moreover, it is at least as important for scientists to have their activities understood by the public as it is for the public to understand science. Then if the scientist refuses to trust popular expression of his ideas to a professional writer, the only alternative is to write them himself.

But there is another factor which prevents scientists from expressing their ideas so that they can be understood by laymen, and this is the connotation of the word "popular." Owing to abuses such as those mentioned above, "popular" in the minds of many scientists has come to mean "vulgar" or "debased." This idea should be cast aside; there is no need to vulgarize or debase scientific knowledge in order to spread it widely. A few examples of successful scientific popularizers will suffice: Albert Einstein (with Leopold Infeld, *The Evolution of Physics*) and George Gamow in physics; Harlow Shapley and Sir Arthur Eddington in astronomy; George Corner and Carl Binger in biology and medicine. No scientist need be ashamed to add his name to this group.

I have said that the scientist has an important responsibility to explain his activities to society as well as to give the public the material benefits of his work. For readers of THE SCIENTIFIC MONTHLY this hardly needs elaboration, for the MONTHLY is devoted to presenting the ideas of one field of science to workers in another, and to presenting the ideas of all sciences to educated lay readers. But someone will object, "The educated lay reader is a far cry from the general public." True, but the process of spreading scientific knowledge and attitudes cannot be done all at once. It must be done in steps at different levels. Those best able to receive knowledge must get it first, and the ideas will spread through the population. The various degrees of popularization may be

seen first from *Science*, then THE SCIENTIFIC MONTHLY, and then such magazines as *Science News Letter* and *Science Illustrated*. Each of these is good in its own way and is useful in its special function.

Some will object that the broad general public does not really want to know about science. It is of course true that the general public does not have the same drive toward knowledge of the physical world that the professional scientist has, but there are a thousand evidences that the public is curious about science. Scientists must capitalize on this curiosity in order to present scientific ideas and attitudes that the public *needs* to know.

But does the public really need to know about science? Automobiles, refrigerators, electric lights, radios, and even atomic bombs are accepted and used by the public, who know not whence these miracles came. The housewife does not need to know about thermodynamics in order to appreciate an electric refrigerator.

The material benefits of science do not usually require scientific knowledge of the users, but the ideas and attitudes of science are at least as important as its material benefits. Witness the transformation of the world in the three hundred years since Sir Isaac Newton formulated his laws of motion. The modern world is built on scientific foundations; the machines used in the construction were scientific, and the ideas which guided the machines were also scientific. It was not necessary for new scientific ideas to have practical uses for them to cause great transformations. The general critical attitude of science toward all phenomena has driven witchcraft into the unenlightened corners of the world. Some of us may regret that we no longer have leprechauns and fairies, but in place of constant fear of supernatural events we now have scientific explanations of earthquakes, plagues, lightning, and the like. We can deal with these phenomena logically and, where we cannot control them, we at least can understand. Alchemy has disappeared and we have chemistry in its place. Astrology has fled before the increasing knowledge of astronomy in the public mind. No one who has heard a good description of the solar system can believe (except figuratively) that his destiny is controlled by Venus. The fact that many people still believe in horoscopes is a symptom of psychological maladjustment in the modern world, and the astrologers, and especially the newspapers who nourish this symptom by casting and publishing horoscopes, are greatly to be blamed. Astronomy has produced no refrigerators or automobiles, but its indirect effects through its descriptions and explanations of the universe have been tremendous.

Another example of an idea without specific practical applications which has had great indirect effects is that of biological evolution. Although technical knowledge of evolution, especially in the past ten years, has advanced greatly since its beginnings in about 1800, the basic ideas have not changed very much; and the false egotistical doctrines of the theory of special creation have fallen away as we have achieved a truer understanding of man's place in nature. The spread of the theory of evolution is an especially good example of the need for explaining science to laymen. None but the most stubborn can today deny the theory of evolution, and the idea has spread through every stratum of society; here we should mention the name of another great scientific popularizer, Thomas Henry Huxley.

Witchcraft, alchemy, astrology, and the theory of special creation have been killed by science; what false belief can science attack next? I submit that one of our gravest national problems which is directly vulnerable to the attack of present scientific knowledge is that of race prejudice.

If a skillful scientific popularizer could teach this nation to accept the ideas of genetics as it has accepted the theory of evolution, race prejudice would quickly die. Any man exercising racial discrimination would be uneasy in his heart, subconsciously knowing that the basis of his action could not be justified in fact, and he would be subject to the ridicule of his fellows. Note that the condition required to reach this state is not the advancement of science but the spread of scientific ideas through the population.

Popularization of science is needed for still another reason, for the good of science itself. Scientific research has been passing through a difficult period since the end of World War II because there is no government department primarily concerned with the advancement of science. Several National Science Foundation bills were presented to Congress in 1946, but none was passed, mainly because Congress, reflecting the opinions of the people, did not realize how necessary a National Science Foundation is. Fortunately the Office of Naval Research jumped into the breach and did a job it was not designed to do, supporting the efforts of pure science. It is hoped that a National Science Foundation will be established this year, but even then it cannot be fully effective unless it is understood and supported by public opinion, and this public opinion depends on general knowledge of science and the methods of science. All good popular scientific books help toward this end, and some, such as *Deserts on the March*, by Paul B. Sears (Oklahoma), an extremely influential book of a decade ago, are directly concerned with public policy. In the United States there is a traditional distrust of government spending; immediate practical results and frequent accountings in dollars and cents are expected. The public must be made to realize that scientific research is always a gamble, that results are slow and uncertain and often not immediately practical, but that science is worth supporting for the knowledge it gives us of ourselves and the world as well as for the unforeseen material benefits which come with this knowledge.

There is another more philosophical and more controversial reason for making every effort to give laymen of every country basic scientific ideas at a level that they can understand. F. S. C. Northrop has recently elaborated in *The Meeting of East and West* his belief that the world's ideological conflicts are based on different ontologies arising from largely outmoded science. He believes that the ideological disagreements can be straightened out only by re-examining the fundamental scientific assumptions on which the ideologies are based and by finding where they are obsolete or inconsistent and establishing a new common ground based on the best scientific knowledge. It seems obvious that, if Northrop is right, his plan can be effective only if the general public of the nations involved is well informed about science. But many scientists do not agree that science can lead to a unique ontology or that it can form a basis for ethical standards. Nevertheless, all agree that the epistemology of science is a great common ground between nations. On this ground scientists of all nations meet as friendly co-workers, and education of the public in the methods and attitudes of science may lead nations to do the same.

It is encouraging to note that the epistemology of science is spreading, though it has sometimes entered fields in which it does not belong. In addition to the physical and life sciences, we now have a whole group of so-called social sciences, with psychology as a bridge. These fields of study have adopted the name and some of the methods of science. Thus we hear of political science, the science of history, the science of economics, and even domestic science. Experts in the humanities may

resent this intrusion, but the spread of the critical attitudes and experimental methods of science has been a useful trend.

The ideas of science are important to everyone, so let the scientist speak forth from his "Ivory Lab," as Jacques Barzun calls it, and let us know not only what he is doing but also what he is thinking. For ideas inconsistent and incompatible with the truth as given to us by science must inevitably die.

I HAVE come a good way through this essay on "The University Presses and the Popularization of Science" with hardly a mention of the university presses. But writing comes before publication, and I am sure that all university presses will back me up in saying that the most important and most difficult part of publishing a good popular scientific book is to persuade a scientist to write it. Any geneticist who wants to refute this statement by writing a popular book on the nature of race will please step forward.

What, then, are the special abilities and special reasons for publication of popular scientific books by university presses? In discussing this topic I can speak only for Princeton University Press, but the principles under which most university presses operate are very much alike. Many people think of university presses as publishers of doctors' dissertations, textbooks, and esoteric tomes. This is a false picture. Most doctoral dissertations are not publishable as such, although they may contain the foundations of future good books. Many university presses, Princeton among them, do not publish textbooks except under special circumstances, leaving this task to the large commercial textbook houses, which are provided with scores of special textbook salesmen. University presses publish a fair number of esoteric books. It is their responsibility to publish these books, but these do not by any means monopolize their lists. The university press lists contain many nonfiction books of sound scholarship intended for the college-educated. Many of these books do not require special training on the part of the reader, but they are written at a level that requires more of the reader than the average book of the average general publisher. There are exceptions on both sides of this broad generalization.

The name of the university on the imprint of a university press book should be a guarantee of accurate and sound scholarship. I believe that for many kinds of scholarly books the university press imprints can be more effective than other publishers' imprints because a university is more than a name on the title page; it is a place whose reputation, and possibly whose halls, are known to the reader. University presses are organized in different ways, but nearly all have a committee composed of members of the faculty who decide purely on the basis of quality and without reference to possible profit or loss whether a book may bear the name of the university. University presses have split personalities; we do not let our right hand know what our left is doing. As soon as a book is approved on the basis of quality, we try to publish it in a way that will sell as many copies as possible. In their advertising and sales departments the university presses operate in very much the same way as the commercial houses.

Why don't the university presses go bankrupt? There are several answers. Most of the presses are subsidized by their universities. Some money-losing books are subsidized or underwritten by individuals or foundations, though this is not so frequent as is sometimes supposed. Some presses, like Princeton, have their own printing plants, the profits of which help to pay for money-losing books. A few presses have tried to operate on the prin-

ciple that any truly good book can stand on its own feet and pay for itself, but this is disastrous because it simply is not so. Many important books are money-losers, but it is the responsibility of the university presses to publish them anyway. The answer for most university presses is that some books lose money and some books make money, and we do our best to come out even in the end. Popular scientific books do fairly well for the university presses in this regard, and thus incidentally help to pay for the very specialized, money-losing scientific books that are necessary for the production of more knowledge, later to be popularized. But the possibility of profit from a popular scientific book should never be a justification for its publication, for a university press should not lower its standards of quality in order to admit a money-making title. Some people think that university presses should publish only money-losing books, but this would be impossible unless the presses printed money as well as books.

Because many people think of popular science as "debased" or "vulgar," it is frequently a real advantage to a popular scientific book to be published by a university press rather than by another publisher. The name of the university on the title page counteracts the suspicion of inferior quality. *Ourselves Unborn* (Yale), *Why Smash Atoms?* (Harvard), *Crater Lake* (California), and *How to Solve It, a New Aspect of Mathematical Method* (Princeton) might provoke suspicion as debased science, but their authors are respectively Director of the Department of Embryology of the Carnegie Institution, Assistant Professor of Physical Chemistry at the Harvard Medical School, Professor of Geology at the University of California, and Professor of Mathematics at Stanford University.

The wide and varied resources of the university are freely available to the university presses in their publishing enterprise. If we are publishing a book on mathematics that we feel should be read by economists, we ask the members of the economics department for advice. Where shall we advertise this book? Where should we send copies for review? Are there any special mailing lists that we should use for circulars and catalogues? What other special groups would be interested? The answers are readily forthcoming, and, in spite of the myth about impractical professors, they produce practical results. In this way we can reach a varied audience and help to bring about the cross-fertilization in the sciences that aids scientific progress. But this kind of cross-fertilization cannot ordinarily be done at the technical level used within each special field. Each scientist is at least partially a layman when he steps beyond his specialty. Interscience writing is a kind of popularization. The need for this kind of writing is shown by the importance of such journals as THE SCIENTIFIC MONTHLY and *The American Scientist*, and a good popular scientific book can perform the same function in more detail, making the ideas of one field of science easily available to all others.

It is generally recognized that the university presses are doing an important job for scholarship by publishing books for specialists, but it is not so often realized that the university presses are doing an important job for society by distributing the products of scholarship widely. Every university press reaches many thousands more readers every year than are contained in its university's enrollment. This is not to say that the university presses are disseminating more knowledge than the universities, but they are disseminating it more widely. In scientific fields they are doing a good and important job of popularization, along with their first responsibility of publishing the primary results of fundamental research.

OBSOLETE LIBRARY BOOKS

By CHARLES F. GOSNELL

The New York State Library, Albany

WHY books get out of date and what to do about out-of-date books is one of the most vexing concerns of the librarian. He is further vexed because, in terms of possible demands by the scholars he aims to serve, any book, no matter how obsolete, may be the essential link in a long chain of "documentation" for the "historical approach" to any conceivable subject.

Declining demand for older titles that have failed to achieve the status of classics is easy to see. In recognition of this declining demand the librarian can cast out duplicate copies. But the impulse to dispose of the last copy is usually countered by the certain knowledge that someday someone will have to have that book. Even the merest scraps of paper may someday be as vital as the Oxyrhynchus papyri. No librarian wants to be called, as some have been, "an enemy of books."

Yet no librarian wants to go on accumulating books indefinitely. It is a fundamental law of nature that indefinite accumulation must eventually lead to stagnation and collapse. Amid these many pressures, the librarian seeks through various forms of clairvoyance to foresee the relative intensity of future demands and to lay up treasure accordingly.

This is an account of an attempt that I made to get some figures on the actual rate of obsolescence of college library books. I wanted to plan for the balanced growth of the book collection and for the segregation and elimination of obsolete materials by replacing old with new.

Heretofore obsolescence has been considered principally with reference to individual and specific titles rather than to groups of books. A librarian could go through his stacks and pick out obsolete or useless volumes one by one. But no general library planning can be done, except on a quantitative basis, in the hundreds and thousands of titles.

Why could not a library full of books be treated like a group of people? An insurance actuary can turn to his tables and predict with striking accuracy how many will survive the coming years, and how long. Why not some similar analysis for books? Books are born, they grow old, and die, certainly as far as our interest in them is concerned.

Statistical bibliography is a relatively new or uncultivated field. But the astronomical proportions to which some of our libraries, their catalogues, and bibliographies in general are growing must force us to consider books as populations. A typical example of what can be done through this approach is the study of "certain biological properties" of literature by Wilson and Fred.

The causes of book mortality or obsolescence are many, varying from pure fad through extension of scientific knowledge and technological advances to fundamental changes in our civilization. The object of the present study is not to discover or to clarify these causes but to analyze their total effect. Deterioration or destruction of books is not true obsolescence. A book may be eternally bright and shiny, but this quality is often proof that nobody wants to *read* it. Hence, no consideration has been given to the physical lasting qualities of a book, but rather to its survival in interest and intellectual usefulness.

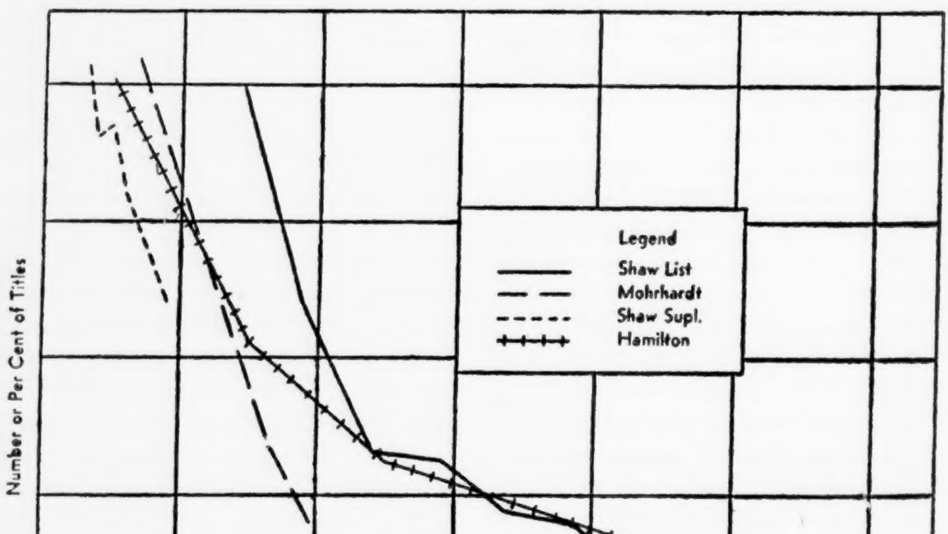
It is a common observation that most people prefer newer books to older and that most selective bibliographies accent the

more recent titles. That preference for newer titles or, conversely, that rejection of older titles is a common factor in many lists. I have sought to isolate it and put it into tangible figures.

WITHIN the past twenty years, college librarians have been fortunate in having had three comprehensive select lists of books prepared at different times. These lists were sponsored by the Carnegie Corporation and the American Library Association. Each roughly followed the same general canons of selection. These three lists or, properly, the publication dates of the books listed constitute the fundamental data of this study. The relative distribution of the dates suggests the rate of obsolescence.

Plotting of frequency curves for the imprint dates showed striking similarities for each of the three lists. First, it was evident that the compilers of the lists were a year or two slow in making their selections. There were few titles bearing dates of the year before each of the respective lists was published. The maximum number of titles per year did not occur until the third year preceding publication of the list. This lag in selection is presumably due to delay in appearance of reviews and lag in general acceptance of new titles by scholars. Accordingly, the figures for the latest year or two in each list were disregarded as without significance for obsolescence.

The diagram shows three curves for the three lists. The initial lag has been eliminated. Following the maximum years, there is a sharp drop in the number of titles per year appearing in each of the lists. This drop is rapid at first but becomes slower as the age of the remaining titles increases. It means that the older a book was, the less were its chances to be included. Many books that were included in the first list were dropped from the second. Many were included in the second and omitted in the



IMPRINT DATES OF BOOK TITLES

IN THE SELECT LISTS AND CIRCULATION AT HAMILTON COLLEGE.

third. The third list was intended to be a supplement to the first and hence had no tail to overlap the years represented by the first list.

The pattern of decline in preference for older books is repeated independently in each of these three lists and actually is found to be substantially the same in many other selections of books. It is not markedly affected by the rate of books produced each year. It is a function of the age of the books at the time each list was compiled.

From the fall in the curves, it is immediately evident that the older a title is at a given time of selection, the less is the likelihood that it will survive the selective process. Each preceding year back from the date of selection is represented by fewer titles. In one group it turned out that there were 100 titles twenty-three years old, 90 titles twenty-four years old, and 81 titles twenty-five years old. In the passing from age twenty-three to age twenty-four, 10 percent fewer titles remained. Likewise there were 10 percent fewer at age twenty-five than at age twenty-four. Therefore the rate of obsolescence for this group is 10 percent.

If a similar list of books had been prepared just a year later, it is evident that of the 100 titles in our first list, only 90 would have survived. For as the group of 100 became a year older, 10 percent of them would have lost their appeal to compilers of the new list.

It was desired to express the principle of obsolescence in a simple formula and to derive comparable coefficients for various subject groups of books. Pearson's criteria of moments, as well as the basic logic of the situation, indicated the type *X*, the exponential curve. Thus the curve of organic decay appears as the expression of obsolescence: $y_r = y_o b^t$. Where y_o is the number of titles at the maximum or initial point, with lag eliminated, b is a parameter expressive of the particular nature of the group of books, and t is time elapsed, then y_r is the number of titles that remains after passage of time t.

When $\omega = 1 - b$, *omega*, ω, becomes the annual rate of decrease in the curve, of the rate of obsolescence. Percent of decrease is expressed by $100\ \omega$.

This rate is almost the exact opposite of the rate of compound interest. It indicates the rate at which the principal, or capital, is decreased or increased.

By shifting the equation to logarithmetic form, $\log y_r = \log y_o + t \log b$, the curve takes the form of a straight line. By the method of least squares, the straight line can be easily fitted to the date of imprint dates in logarithmetic form. And for simple graphic analysis and illustration, the imprint dates may be plotted directly on logarithmetic grids.

Through the method outlined, rates of obsolescence have been computed for the three select lists and nineteen subject subdivisions. For the Shaw *List*, including over 12,000 titles, the general rate of obsolescence was 8 percent. Individual subjects varied markedly in rate. Physical education was high, with 21.6 percent. Classics was low subject, with a rate of only 4 percent per year obsolescence. Chemistry and physics were in the upper group, with 12.9, astronomy and geology were toward the bottom, with a rate of 6.3, and mathematics was 6. The social sciences, except for history, were generally high, whereas the languages and philosophy were low.

There was substantial agreement in rates of obsolescence between the subject sections of the three lists. The rank correlation between the rates for the Shaw *List* and the Morhardt *List* was +.84. Further detailed analysis revealed no relationship between the total number of titles in a subject group and its ω, nor between the number of titles in its maximum year and the rate of obsolescence. The rate seems to be a property

peculiar to each subject and not a variable dependent upon some other continuous variable. No other ordinal relationship of the respective subject sections has been found to correlate with ω in either the positive or the negative.

There seems to be a slight tendency for some larger subjects to have a lower rate. Perhaps, conversely, a subject having a lower rate tends to accumulate more titles. This is true in English, history, and "general." Yet mathematics, music, and philosophy, all among the smaller groups of titles, fall low in ω.

Similarly, small subjects might be small because their titles do not long survive or because their rate of obsolescence was high. This may be the case with physical education and chemistry and physics. But geography, one of the smallest groups, has a medium rate. Mathematics, music, and philosophy are small in number of titles and have low rates.

In some fields, such as chemistry and physics, psychology, and mathematics, a large proportion of current research is published in professional journals rather than in books. Many of the books are either textbooks or handbooks and reference tools. The bearing of this fact on obsolescence is difficult to assess. From one point of view, the need for current publication of new material is met by the journals, and the output of new book titles is consequently reduced. Conversely, the rapid developments characterized by the journal articles must occasion frequent revisions and changes in textbooks and handbooks and thus should be reflected in a high rate of obsolescence.

It is quite possible that the omega for a given subject might change over a span of years. This change might be due to a general change in approach or in methodology in a subject; or to a sudden increase of interest or of expansion in the field. It has not been possible to isolate any such changes within the limits of the present study. The period of time covered is not long enough to show clearly any fundamental trends.

The possibility of a general shift in the rate during the period 1890–1920 is suggested by the yearly total for the Shaw and Mohrhardt *Lists* and in many subject sections. In the process of fitting the straight lines, it was found that nearly all curves rose above the straight lines for the period 1900–1910. In the succeeding ten-year period they fell below. This pattern, or cycle, is a function of contemporary conditions, not of the age of the titles.

The rise may be ascribed to a number of factors. There was an increased production of books in the period. There may have been an increased proportion of desirable books in the period; or some of the older books may have survived longer than usual because enough stronger titles did not appear in the war years immediately following. The drop in the next decade may be due to a reverse of these conditions. Certainly it was not due to a wartime drop in production, for there was a flood of publications in history and political science during the war years. It is more likely that the very urgency and immediacy of these publications in a critical period condemned them to short life.

In this connection, Sorokin has declared that "purely quantitative (astronomical) time cannot replace sociocultural time, and is inadequate for the study of sociocultural phenomena." As an example, he points out that "one year of existence of a modern social group is packed with more numerous and greater changes than are fifty years of existence of some isolated primitive tribe." Some investigators have studied a similar problem in the process of forgetting, where the nature and intensity of activities between the learning period and the retention test are factors.

Fitting the exponential equation to the data and computation of ω makes possible

certain generalizations regarding life expectancy and mortality of books. Of course no definite predictions can be made in terms of individual titles. But regarding a given group, predictions can be made with the same justification as they are in similar situations in life insurance and annuities.

The annual mortality for any given group is expressed by ω. The number of titles remaining in the group y_r after the lapse of time is given by: $y_r = y_o (1 - \omega)^t$.

It is possible to compute the time required to reduce an initial group to any given remainder and the average life, or life expectancy. There are many applications of the exponential equation which have been fully explored by workers in other fields and which need not be mentioned here.

THE three select lists of books have been generally accepted as practical standards for college library collections. But no general principles which emerge from analysis of these lists can be accepted until they are compared and tested against actual library situations. To make these tests, samples were taken from the catalogues of five college libraries. The library samples showed generally lower coefficients, evidence that the libraries had not discarded old books as rapidly as the compilers of the ideal lists did. But there was strong agreement between libraries and lists insofar as the same subjects, such as chemistry and physics, were consistently high in rate of obsolescence, whereas history and the classics were low.

The select lists, and even the libraries, are made up in anticipation of need, but they are not actual expressions of need. There is good reason to believe that both the compilers of the lists and the librarians were practical choosers of books that faculty and students would want, but it is seldom indeed that an accurate check of reader demand is possible. Thousands of call slips are filled out daily, but they are never kept and classified or analyzed to find out the fundamental trends in reader demand.

An exceptionally detailed analysis of daily use was made over a three-year period by Lewis Stieg, librarian of Hamilton College. Among other items, he took the trouble to tabulate the publication or imprint dates of the books that college library readers asked for. A curve for one year's circulation has been plotted as a part of the diagram. The curves for two subsequent years are almost exactly the same. The chief difference is that in each succeeding year there is a slight displacement from the previous year, corresponding to what we should expect to happen as a result of a year's difference in time. The shape of the curve is the same, but it is moved over one unit, corresponding to one year.

Thus there is evidence that in actual use of a college library readers are interested in more recent books. The decline in interest per year, in the older books, falls like the decay curve which has been described. Loss of interest in older books is expressed as a process of exponential decay. It drops rapidly but never totally dies out.

From the Hamilton data it was possible to compute an ω, or rate of obsolescence, of 5 percent per year. This compares with 8 percent in the Shaw *List*. The lower rate for circulation of books at Hamilton may be accounted for by several circumstances. First, the collection there, nearly 200,000 volumes, was much larger than the lists and contained much more older material. Second, the instructional program of the college may have been planned to take advantage of greater resources by use of older materials beyond that contemplated by the compilers of the select lists. The compilers listed only 0.2 percent of books published prior to 1850, whereas at Hamilton 1.24 percent of the circulation was in titles published prior to 1850, including sixteenth- and seventeenth-century titles that are rarely found in a college library.

Some of the older titles may have been withdrawn because of interest in their physical form rather than for ordinary reading or reference use. For the purpose of this study of obsolescence, use of a Gutenberg Bible would not be significant. The Gutenberg Bible is noted as a physical specimen, a veritable museum piece. It is a rare scholar indeed who would or could read it because he wanted to read a Latin Bible.

But the fact remains that, when the librarians sat down to compile some ideal lists of books, they put less emphasis on older titles than a record of actual demand for these titles would justify. And, while they sought to concentrate on the latest and best editions, there is still a legitimate demand on the part of scholars and students for first editions and specimens of the earliest printings.

Obsolescence of books is a vast new field, and I am conscious of having scratched the surface of only one corner of this field. But I hope that I have turned up a few useful facts and some ideas. It seems worth while to list, for the librarian and scholar, some of the possibilities for future research and practical application.

The first task is to clarify and standardize the coefficients of obsolescence by wider application and study. My computation is presented as merely illustrative of the method rather than a final statement of fact. I do believe that many librarians can discard old books more freely than they have in the past. But what happens when a library does not discard old books is itself a problem for further study. By what curve or law the growth of libraries takes place and what may be expected in the future are open questions. There must be a saturation point for the largest libraries, but where it is nobody knows.

The distribution of imprint dates is a powerful tool for the analysis of book collections. Heretofore, libraries have been compared with respect to size of their collections and annual additions or with respect to their holdings of specific titles. Now it should be possible to evaluate in quantitative terms at least one factor in the quality of book collections.

The extent to which the omega computed for a given library may differ from a generally accepted standard may be taken as an objective indication of its deviation from the norm. It must be remembered, however, that such figures as may be derived are no substitute for special expressed purposes or policies of a given library. If a library chooses to be different and has good reasons, therein lies the justification for deviation. But the deviation can still be accurately measured.

If, in a study of its collection of sociology, a college library finds an omega of .01, whereas the generally approved figure for comparable libraries is at least .08, there is an obvious deviation from the norm. The cause for this deviation may be that the library is not adding enough new books or that it is not discarding older material. If the generally accepted y_0 for sociology is 40 titles within five years (that is, the maximum point on the curve) and the library has had only 20 titles at maximum, then it has not bought enough new books each year.

But if the library has been adding an average of 40 titles per year, the slight slope of the curve is due to failure to discard older materials. This failure may be examined in the light of the purposes of the library. If there is a deliberate policy of retaining deadwood for some definite purpose, such as "historical approach" to the subject, then no further justification is needed. But it must be remembered that the cost of housing and caring for the older material can legitimately be chargeable only to this special use.

An offer of a large gift of older material can be weighed with regard to what it will do to the present distribution of imprint

dates in a library. It might fill a gap left in the past or, more likely, it will increase the proportion of obsolescent material in the form of a camel's hump.

For the college library faced with the necessity of storing or setting aside the lesser-used portions of its collections, as suggested by many and practiced by few, the formula and rates may be used in planning what to segregate and in estimating the demand for the segregated material.

Assuming a rate of obsolescence of 5 percent, the minimum suggested by the circulation experience at Hamilton, the half life will be approximately fourteen years; that is, half of the useful collection will be in titles fourteen years old or less. Likewise three-fourths of the demand will be for books less than twenty-eight years old or certainly less than thirty years old. The average life, or life expectancy, would be about twenty years.

In many college libraries titles over thirty years old would comprise at least half of the collection. But only a small proportion would be in active or potential demand, probably not more than 10 percent. Thus 50 plus 10 percent, or 60 percent, of the collection might account for 90 to 95 percent of the circulation. Because the remaining 40 percent of the books would be used so little, these volumes might be removed to a less accessible place of storage with very little inconvenience; or they might be removed from service entirely, with a loss of only 5 to 10 percent of the total use of the library. For the undergraduate, a live and concentrated collection would be far more satisfactory. He would be spared much floundering among dead or misleading titles.

Within a library it may be desirable to compare several sections, with a view to determining relative need for book funds. In budgeting departmental purchases, it is important to know approximately how many titles are required each year in each subject, and to know that replacements in such fields as classics are needed less urgently than in certain of the sciences. On the other hand, the professor of classics may claim that money is more wisely spent on his books with longer life expectancy.

One of the least-explored areas of cost accounting is that for public and semipublic nonprofit institutions. Understanding and statement of the rate of obsolescence of library book collections in financial terms would be an important contribution toward the solution of this problem. Such information should also provide a useful lever in annual book budget requests. The librarian can readily demonstrate how many titles must be purchased annually to keep his collection up to the standards set for it.

The publisher has other phases of the accounting problem. He must decide when to dispose of unsold inventories of older books. His editors must decide when a book needs to be revised or even when a new book is needed in a given field.

REFERENCES

Gosnell, Charles F. *Obsolescence of Books in College Libraries.* Amer. Lib. Ass. Chicago. 1944.

Mohrhardt, Foster E. *A List of Books for Junior College Libraries.* Carnegie Corporation of New York Advisory Group on Junior College Libraries. Amer. Lib. Ass. Chicago. 1937.

Shaw, Charles B. *A List of Books for College Libraries.* Carnegie Corporation of New York Advisory Group on College Libraries. Amer. Lib. Ass. Chicago. 1931. (*Supplement,* 1931–38.)

Sorokin, Pitirim A. *Sociocultural Causality, Space, Time; A Study of Referential Principles of Sociology and Social Science.* Duke Univ. Press. Durham. 1943.

Stieg, Lewis. A Technique for Evaluating the College Library Book Collection. *Lib. Quart.,* **13**, 34–44, Jan. 1943.

Wilson, P. W., and Fred, E. B. The Growth Curve of a Scientific Literature; Nitrogen Fixation by Plants. *Sci. Mo.* **41**, 240–50, Sept. 1935.

BOOKS—AGENTS OF WAR AND PEACE

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NATIONAL boundaries mean less, and books mean more, to scientists than to most men. The destruction of millions of books and the cutting of intellectual communications between countries during World War II present a vivid threat to American scientists, who closely share with their colleagues overseas a vital concern for the damage thus done to world learning. It seems fitting, therefore, that an American scientific publication should this year review the destruction of books throughout the world and American help in repairing the losses of this destruction and the equally damaging isolation of war years.

World War II differed from preceding wars in that it was very precisely tailored for the destruction of books and libraries. Its scale of operations was global; its theaters covered half the earth. Unlike the war of 1914–18, this was a war of mobility, and installations that were not ground to dust the first time the war machine passed over them often did not fare so well the second and succeeding times that they found themselves in the path of operations. It was a war of aircraft and aerial bombardment, in which the target was often indiscriminate. The concealed mine, the incendiary shell, the blockbuster, all were diabolical instruments to destroy the civilian target as well as the military objective.

The fact that this was a war which was inspired to destroy cultures accounted for the loss of more books than any other single factor. Books are not only the evidence but the very instruments of competing cultures, and as such they became not only weapons to wage war but also the enemy to be tagged for obliteration. This identification of the book as the enemy became apparent long before the beginning of hostilities when the first public burnings of books occurred in Germany in 1933. From then until 1945 the destruction of libraries and book manufactories had been a characteristic depredation systematically undertaken by both Germans and Japanese.

Under normal conditions the book is one of man's less perishable inventions. Even its precursors—the manuscript, the roll, the tablet—have often come through centuries in surprising quantity and in rather usable condition. The book and the library have been respected and safeguarded, even in war, as the very corporate mind of society. In 1939 man very literally turned upon himself and deliberately strove to destroy the physical instruments of that mind. He succeeded in a large measure.

The National Library of Yugoslavia in Belgrade, with its priceless collection of Serbian treasures, was destroyed by German incendiary bombs in 1941. In Italy the University and Pontiana libraries in Naples, the National Library in Palermo, the Civic Library in Turin, have disappeared in rubble. The archives of the city of Naples were burned by the Germans in reprisal; the great Columbiaria in Florence was blown up by the Germans when they mined the approaches to the Ponte Vecchio. The 700,000 volumes of

Charles University Library in Prague were stolen as a unit. In Russia casualties include the Ukrainian Academy of Sciences Library and both the State Historical and State University libraries of Kiev. Allied strategic bombing destroyed many of the great libraries of Germany, including the State Library in Berlin. The great publishing centers in London and Leipzig were obliterated.

These are but a handful of the great libraries which the world has lost. The complete list runs into hundreds—thousands—of libraries, large and small, in Europe and the Far East. Just what has been lost will, in many instances, never be known, for often the records of library and archive holdings were destroyed with them. Buildings can and will be replaced. The working tools of scientists and scholars, the archives that record the history of a city or a nation for centuries, the bibliographical treasures of entire cultures: many of them can never be replaced. Mankind will be forever poorer. Humanity will have to do some of its work a second time.

The entire subject of the destruction of books and libraries is a maze of paradoxical complications and contradictions. We must not forget that we ourselves, as the perfectors of aerial bombardment, are physically if not morally accountable for much of this devastation. Millions of volumes were burned by the enemy, were reduced to paper pulp to feed their propaganda machines, and during the freezing winters of eastern Europe became fuel for their invading armies. Both Germans and Japanese had organized commissions of specialists who were able to do a competent job of the bibliographical looting of the libraries of half the world. Libraries, hastily packed and transported to areas of supposed safety against aerial attack or looting, were destroyed by rain, mold, or rodents.

In France, German "inspectors of libraries" carefully protected the great public institutions, and, indeed, some very important bibliographical developments occurred in France during the occupation. The same German inspectors savagely pillaged, burned, and unspeakably desecrated great private collections. In Poland and the Balkan states where the Nazi hand was heaviest, the library resources of each country were "improved" through the creation of regional research centers and the consolidation of many smaller monastic and private collections. The Nazis undertook elaborate plans to rebuild and restock libraries that often they themselves had destroyed earlier.

In eastern Europe millions of volumes in libraries, private collections, bookstores, and government archives and offices were burned—often with some ceremony—in great public fires. Other millions of volumes were fed into pulping machines for reshipment to Germany. In Yugoslavia both the library of the National Institute and the stock of Getsa Kohn, the largest publishers of the country, were used as raw material for the production of new paper.

Two remarkable photographic studies of the treatment of libraries by the Germans show what happened to the University of Liége in Belgium and at the Polish Library in Paris. Books have been taken away—stolen, burned, dispersed—statuary lies in heaps of rubble on the floor, wainscoting and decorative woodwork have been pulled from their walls to be hacked to pieces, walls themselves have been destroyed.

The mobility of the war and the tremendous destruction from the air caught the world off guard. As the war fronts moved rapidly over areas of hundreds of miles, the custodians of libraries, archives, museums, and galleries frantically endeavored to protect their treasures. Their efforts were often pathetic, for they lacked equipment, personnel, transportation, and, above

all, a place which promised some degree of immunity from the devastation they could see on every hand.

In China great libraries were packed in boxes and shipped into the interior by horse and oxcart as the Japanese advanced. In France, when the great library of the Chapter of St. Thomas was threatened, it was hurriedly evacuated for storage in a rural area. There the books were destroyed as completely by rain, mold, rats, mice, and insects as they ever could have been by bombs or artillery fire. The original repository, a building at the University of Strasbourg, remained undamaged. In Holland the monks of the Abbey Van Berne distributed the early printed books of the monastic library among neighboring farmhouses. Virtually all were destroyed by natural causes, by theft, and by shellfire. The Abbey buildings are intact.

In the Philippines many of the public and university libraries of Manila were dispersed among private homes, where it was presumed that they might be safe. With the destruction of virtually the entire city, nearly all were lost.

In Italy the Germans first distributed artistic properties in rural castles, monasteries, and châteaux. As the Allied armies approached and as air raids became more frequent, they gathered up such material by train and truck—at a time when transportation facilities must have been very precious to them—for storage in the Vatican. Between November 27, 1943, and June 3, 1944, 664 cases of priceless books went to the Vatican in this way. The American Army took Rome on June 4.

THIS, then, was the situation as the war ended: Many of the most culturally significant countries of the world had seen great numbers of their libraries, public and private, destroyed as a deliberate or an incidental part of the war. All countries had been deprived of the normal exchange of publications and ideas. Scholarship was disrupted. The tools for printing books and magazines had, in many cases, been destroyed. Paper pulp was at a premium.

In spite of their pathetic primary needs—food, shelter, and clothing—foreign scholars who had suffered through the war and were still suffering long after its end were addressing very moving appeals for books and other printed materials to their more fortunate colleagues in other areas. Food for the mind is as important as food for the body, and in a technological age there is a direct relation indeed between research materials and the ordinary processes of living.

Nowhere in the world was there at the end of the war such a wealth of printed materials as America could provide. American medical journals with reports of seven years of progress unknown to many doctors abroad, engineering publications describing new techniques in building, educational books and magazines presenting the work of American schools, books, journals and pamphlets describing developments in the basic field of agriculture, descriptions of the vast strides made in the chemical industries—these are illustrative of the types of printed materials which were desperately needed and which were available in the United States and Canada.

Fortunately, many Americans did not wait until the end of the war to begin collecting such printed materials. Early in the war the American Library Association set up a Committee on Aid to Libraries in War Areas. This committee appealed to librarians throughout the country to collect all scholarly materials available during the war years and to store such materials for later shipment abroad. This appeal resulted in the collection of 600,000 periodical issues. An additional plan, presented by the International Relations Office of the American Library Association

and supported with funds from the Rockefeller Foundation, provided for the purchase of sets for the war years of 360 of the most valuable periodicals.

Books, as well as periodicals, have been purchased by the International Relations Office. The Rockefeller Foundation has supported the International Relations Office in its purchase of 35 sets of books published since 1939 for distribution to libraries in 24 countries. The Rockefeller Foundation has also financed the filling of specific requests from many libraries throughout the world. The Department of State, as a part of its cultural relations program, has supported the purchase of sets of books for China, specific titles requested for the Philippines, and very large purchases for Latin America.

The program for the collection of donated materials was broadened by the efforts of the Council of National Library Associations through its Joint Committee on Books for Devastated Libraries, made up of representatives of twelve American and Canadian library associations. An appeal for a large-scale program, coordinating the efforts of many individuals and many agencies, was made at a meeting called by the State Department in Washington February 28, 1945. The Joint Committee accepted that responsibility and sponsored the American Book Center for War Devastated Libraries. The Book Center has thus far collected almost one million volumes and has distributed 700,000 of those volumes overseas.

The Book Center sends its materials in all cases to committees in the various countries. These committees, composed of librarians from the various types of institutions, base distribution of the books upon firsthand knowledge of the needs and present resources of the libraries. In addition to the materials sent for distribution by the national committees, the Book Center transmits shipments collected by individuals or groups to specific libraries abroad.

The American Book Center has called upon, and has received the aid of, many other organizations. The Library of Congress has given space for offices and physical operations; UNRRA has made shipment of more than 2,000 cases of books to the countries which it serves. The State Department has facilitated arrangements overseas. Such professional organizations as the American Chemical Society, the Engineers' Joint Council, and the National Educational Association have made strong appeals to their memberships.

Most recently organized of the programs for aid to war-torn countries is the Commission for International Educational Reconstruction. This advisory office, set up by a number of educational organizations, the State Department, United Nations Relief and Rehabilitation Administration, and the United Nations provides coordination and stimulus for all programs interested in the shipping of educational materials overseas. The commission serves all educational levels with all types of materials. In its book program it has worked closely with the American Library Association and the American Book Center. The commission has been called upon by Dr. Julian Huxley, Director General of the United Nations Educational, Scientific, and Cultural Organization, to assume leadership in stimulating American voluntary organizations to supply educational materials to those countries that so desperately need them. The commission is now organized to assume this task.

In addition to the large-scale American efforts there are a great number of programs operating in special fields—programs which in many cases have produced notable results. Such institutions as the libraries of the University of Nijmegen and the University of Caen, both totally destroyed in the war, have benefited greatly from

programs organized to restock their collections. The efforts of single individuals have been, in many instances, remarkably effective. A large number of such enterprises have coordinated their appeals, their collections, and their shipping with the larger agencies which have been mentioned, and at the same time have retained the values of their specific programs.

The use to which American publications can be put in countries where English is not the official language is constantly surprising to American students. The welcome given to American publications is evident in statements such as this from Greece:

> The great work of civilization, reconstruction, and education which your organization has undertaken in behalf of Greece will. . .prove of great use in order to make the Greek people understand the way of thinking of the Americans and the spiritual movement of the United States of America.

Nearly every letter from abroad emphasizes the need and the usability of American publications. From Yugoslavia is written:

> The National Library was burned down by the Germans, who lit it to provide illumination for convoy loading during the final night of their occupation of the City. There is, apart from this, a great lack of American technical books and this impedes many of the processes of recovery as well as limiting a most important avenue of friendly liaison.

Medical literature has been given a high priority in all shipments.

> I would like to tell you [writes a Czech] how pleased all medical doctors and research workers in Prague were when I was able to tell them that the complete series of medical reviews and journals which you contributed to the Medical Library of the Charles' University in Prague were on their way to Czechoslovakia. There is a lot of hunger in my country, yet I can assure you that the desire to know about the progress in medicine and sciences is just as great. You can really be proud of what you have done in order to satisfy this desire. I am certain that your gift offered in the right moment will never be forgotten.

There is a continued need for American scholars to support programs designed to supply books to their colleagues overseas. The need has not evaporated with the coming of peace. It will continue for at least several years to come. Americans cannot supply all the materials of scholarship needed abroad, but they can supply many of the basic tools until reconstruction, exchange of currencies, and transportation facilities make possible once more a normal flow of books. The scars of war will never be erased, but the wounds need not remain open and festering sores. The rebuilding and the restocking of many libraries will help to heal the grievous wounds which civilized men have inflicted upon each other.

(If you wish to aid or if you wish information concerning the emergency programs mentioned in this article, you may write to any of these three organizations in Washington, D. C.: The International Relations Office of the American Library Association, ℅ Library of Congress; the American Book Center, ℅ Library of Congress; or the Commission for International Educational Reconstruction, 744 Jackson Place, N. W.)

Book Reviews

ETERNAL LANDSCAPE OF THE PAST

The Ancient Maya. Sylvanus G. Morley. xxxii + 520 pp. Illus. $10.00. Stanford Univ. Press. 1946.

AFTER forty years of field explorations and study of the Ancient Maya, Dr. Morley has finally produced the general book which has been eagerly awaited by all of those interested in the most intriguing civilization of the New World. There are few who will be disappointed, for here, conveniently arranged and clearly expressed, is a compendium of information covering all phases of the life and known history of the people who achieved the most conspicuous cultural advance in pre-Columbian America. It is doubtful if a more colorful story could be told of any single group in the history of mankind.

The semiliterate Maya left behind them a record in their inscriptions, art, and architecture that allows a much more complete reconstruction of their past than is usual among American aborigines. The documentation of their history during the first century of the conquest, by both native and Spanish historians, is unusually full. This documentation, joined with the archeological record, gives us the unique and continuous picture of thirteen centuries of achievement.

Morley's text is made more vivid by the careful selection of illustrations, which in many instances portray more strikingly than the printed word the unusual accomplishments of this gifted group. Of greater value to the student and professional are the tables which present chronologically practically all significant aspects of Maya culture; and comparative charts which equate them with other Middle American cultures. Of interest to lay readers will be Morley's table of fifty superlatives, comprising the "biggest," "most beautiful," "oldest," "latest," "highest," and so forth, as related to achievements in art, architecture, and the inscriptions.

In his preface, Morley divides the content of the Maya story into four major headings: the people and the region, history, manners and customs, and an appraisal of Maya civilization and its comparison with other aboriginal American cultures. It is a tribute to the even balance of the subject matter that hieroglyphic writing, arithmetic, and astronomy have been condensed into a single chapter.

In treating of the periods of Maya history, Morley still uses the classic terms "Old Empire," "Renaissance," and "New Empire," although he is careful to point out that these have no political significance. His breakdown of these periods equates them with the calendar system and the more recent subdivisions based on ceramic stratigraphy.

It is inevitable that theories will differ when dealing with periods as remote as those in which the early Maya flourished. The present incomplete status of archeological research in Middle America still leaves a wide field for speculation. There are many who feel that the emphasis on work in the Maya area during the past century has tended to magnify the accomplishments of the Maya at the expense of other groups. The conspicuous achievements of the Maya in architecture and their habit of carving elaborate hieroglyphic inscrip-

tions in stone were probably the factors which did most to bring about this emphasis. The picturesque jungle settings of the majority of the ruins intensified their romantic appeal—an appeal which has certainly never diminished with this reviewer.

In the present book Morley leaves no doubt that he represents the classical school, which looks upon the Maya as the principal fountainhead of Middle American culture. Early in the book he states this thesis in general terms.

> Owing to the almost unequaled isolation of the Maya country—surrounded on three sides by vast and, in those days, completely unknown bodies of water, and on the fourth by the lofty Cordillera, south of which Maya culture never seems to have penetrated—the Maya developed their unique civilization practically without influence from the outside. Its origin, rise, and first florescence in Old Empire times were exclusively due to the native genius of the Maya peoples, stimulated and conditioned by the fertile, happy environment in which they were fortunate enough to have lived. . . .This whole picture of unique geographic isolation, coupled with an outstanding indigenous civilization that developed in a region culturally so highly isolated and practically free from all alien influences, constitutes perhaps the best laboratory for the study of an early civilization to be found anywhere in the world.

Many of the specialists in the Maya area no doubt will agree with this, but there are others who will feel it to be a considerable oversimplification of the problem.

He discusses the theory that maize was developed in South America and rejects it in favor of the opinion that maize agriculture originated in the highlands of Guatemala and that with it was developed the early Mamon pottery phase. Mamon pottery then spread over Middle America with the diffusion of maize agriculture. When this early complex reached the Peten region, the rich tropical soil permitted intensive production and furnished the stimulus which permitted the Maya to originate and develop their arts and complex calendar system.

In presenting this thesis, he discusses briefly and rejects the theory that the Maya may have received the calendar from some group or groups lying to the West. The early dates on the Tuxtla statuette and the stelae of Tres Zapotes and El Baul he feels cannot be considered as contemporary because in the first place the decipherment on none of them can be considered as certain and in the second place all of them are non-Maya in style.

In accepting and using the Thompson correlation for converting Maya dates to the Gregorian calendar, Morley follows the practice of the great majority of present-day epigraphers.

Regardless of the stand taken on such controversial points, there will be little disagreement with the scholarly handling of factual material. In fact, the book brings together such a mine of information on all aspects of Maya life that no one, amateur or professional, interested in the anthropology of Middle America can afford to be without it.

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AIRCRAFT INSTRUMENTS

Dials and Flight. Assen Jordanoff. vi + 359 pp. Illus. $5.00. Harpers. New York. 1947.

THIS is not a book about dials. Nor is it a book about flight. It is a book about aircraft instruments, their construction, use, and maintenance.

The organization and content of the book suggest that the material may have been assembled in the preparation of a field maintenance manual for one of the armed services. There are no discussions of general flight principles, no introductory chapter, no general chapters. Rather, each chapter takes up a specific type of instrument and discusses the kinds of things which a

mechanically interested pilot or a general aircraft maintenance man would like to know about that instrument. The outline followed in each chapter is essentially the same. For this reason the content of the book is well illustrated by the following section headings taken from the chapter on the air-speed indicator: Purpose, Location, Description and Operation, Using the Air-speed Indicator, Calibrating the Air-speed Installation, and Servicing the Air-speed Indicator.

The book is in four parts. The first deals with flight instruments, the second with engine instruments, the third with navigation instruments, and the fourth with automatic pilots. The thirty-five chapters go far beyond the instruments found in private planes but, so far as commercial or military flight is concerned, are incomplete in their omission of all reference to radio navigation aids and radar equipment.

The content of the book is made easy to understand because of the fact that the text is supplemented by a great many handsome illustrations. Each instrument is shown in at least one half-tone, cut-away type diagram. Some two hundred line drawings cover additional details of instrument structure, instrument function in flight, and various aspects of instrument disassembly and calibration.

Instrument servicing and the detection of casualties in the various systems are outlined in a clear, step-by-step manner. Adequate warnings are posted whenever the repair work or testing is something which should be undertaken only by skilled instrument mechanics.

Jordanoff is the author of a number of other books on flying. The reviewer is advised by friends more familiar with these earlier publications than he that the present volume is not unlike the others.

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COMPLETE AS PALLAS

A History of the University founded by Johns Hopkins. John C. French. xii + 492 pp. Illus. $4.75. Johns Hopkins Press. 1946.

IN 1816 Tichnor remarked, "We are mortified and exasperated because we have no learned men, and yet make it physically impossible for our scholars to become such." Sixty years were to pass before a university was created, "complete as Pallas," which was to kindle the flame that would light our path to intellectual achievement. The absorbing story of that educational renascence and of the life of the institution which gave it birth is related with warm enthusiasm, yet with nice judgment, by Dr. John C. French, distinguished Librarian Emeritus of The Johns Hopkins University.

What the term "university" meant to the Quaker merchant of Baltimore, who rose from grocery clerk to amass a fortune, we do not know. Yet he desired to promote education and to establish a hospital as a part of the medical school of the university he was to endow. He was more specific as to the hospital, even to the grounds. These he would have "planted with trees and flowers and surrounded by iron railings." Possessing small taste for publicity, he seems never to have thought "the mastery of finance a warrant for his speaking with authority on such matters as education." He did, however, subject his university to the financial vicissitudes of a great railroad, but this, as Dr. French remarks, may "in the long run have been a source of more good than harm."

He was an acute judge of men. In choosing the original Board of Trustees, he was on sure ground. Seeing what these twelve men achieved, there can be little doubt about his judgment.

To those sagacious and tolerant merchants and lawyers—one was a physician,

a half were Quakers—fell the grave duty of creating a new American university. Unique in university history, they established a reading course for themselves in works about education, many of which reflected the controversies of the time. "Feeling their way toward a radically different concept of university education," they sought advice. President Angell of Michigan cautioned them "not to go and erect another college like four hundred already existing in the land, but to strike out boldly at once and make a great graduate university."

They called Daniel C. Gilman to the presidency. He would create a university which "should extend its influence far and wide and would make it the means of promoting scholarship of the first order."

To this end came Gildersleeve in Greek, with his literary taste and skill and a nimble, caustic wit; Sylvester in "our divine algebraic art," maker of mathematicians, who founded the first of the learned journals, and whose teaching "broke every rule of pedagogy;" also came the systematic Remsen in chemistry, whose administrative abilities "later brought him responsibilities from which he should perhaps have been spared;" and then Martin in biology and Rowland in physics.

What these men wrought may be found in the careers of the twenty fellows who joined that first faculty. "Probably no expenditure of ten thousand dollars in American education has ever had so large and so enduring a return from the investment." There was Brooks in the biological sciences; Craig in mathematics; Morse in chemistry; Royce in philosophy; and Adams in political economy and finance, significant for his attack on the social doctrine of *laissez faire*.

These men alone from the literary and scientific department were justification of the trust imposed by Mr. Johns Hopkins, but there were still other far-reaching influences on the intellectual life of America. There came the genius of William H. Welch, first Professor of Pathology, who, together with Osler, Halstead, and Kelly, formed the core of the medical faculty with its hospital, which was from the beginning a teaching hospital with students at the bedside, "designed both to relieve suffering and to advance medical knowledge." Later the medical disciplines were augmented by the School of Hygiene and Public Health and by the Institute of the History of Medicine. Again it was the vision of Welch that triumphed. Medical education was emancipated from the method of the old schools with their four or five months of lectures, heard twice during two successive years, and remote contact of the student with the patient.

The wisdom of Gilman and the trustees was evident in the influence of the university on American education. It "stirred to vigorous life impulses toward advanced courses in institutions in which the college tradition had been all-powerful, and it encouraged new foundations devoted primarily to university work."

But these achievements did not come without opposition. There were those who would have acquired "elm shaded lawns and formal quadrangles" instead of the plainness of the Howard Street site, as there were those who thought it was the plain duty to provide an institution that would "benefit the largest number of Baltimore boys, perhaps with emphasis on agriculture and the mechanical arts." Others there were who opposed the obvious leaning toward science with the "fear its influence would be hostile to religion." And one, Colonel Scharf, criticized the trustees for "wasting the income on a few graduate students, each of whom cost $700 a year to educate," and for failure "to come down out of the scholastic clouds."

This is an honest book that might well be read again and again by those who find in

their hands the destiny of our educational institutions. Its reading would give renewed hope and assurance, and point a way to the future. For the university still must blaze the way. Problems transcending even those already met in the physical and biological sciences remain unsolved. They dwell in the relations of man to man, and of nation to nation.

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WHAT'S PAST IS PROLOGUE

The Path of Science. C. E. Kenneth Mees (with John R. Baker). xii + 250 pp. $3.00. John Wiley. New York. 1947.

IN THESE times of intensive specialization it is good to read a book by a physical scientist whose interests are broad enough to include the humanities and the social sciences. The author, Vice-president in Charge of Research at the Eastman Kodak Company, deplores the cleavage between the humanities and the sciences. He writes: "The humanists must understand what the scientists have done in the past, are doing now, and may do in the future; while the scientists must see their work in the light of history and in relation to the effects that its application to social conditions will produce." In writing this book on the "development of modern science against the background of history" the author has carried out this point of view.

The early part of the book is devoted to a discussion of various cycle theories of history, from the early Greeks through Spengler. The author points out that while there have been ups and down in the history of art, literature, and architecture, the path of science has "step by step advanced through the ages." He compares the pattern of the historical process to that of a helix, or coiled spring, "in which the vertical component represents the growth of scientific knowledge, which increased rapidly after the sixteenth century and then became the dominant factor in the history of civilization."

In the chapters which follow the author discusses the nature of science and the development of scientific method. He traces the growth of science through its beginnings among the Greeks, its collapse in the Middle Ages, and its rebirth with the breakdown of feudalism and the rise of capitalism. The story of the growth of physics, chemistry, and biology brings together a mass of material on three of our most important scientific disciplines and makes fascinating reading.

In discussing the present organization for scientific research and the developments likely to occur in the future, Dr. Mees outlines the growth of research laboratories in industry, endowed technological institutes, and government-operated research laboratories in the United States and in other countries. Despite these new and important developments, Mees believes that the scientific department of the university is "the basic institution upon which everything else depends. . . .It is from the universities that the bulk of the new ideas by which science is advanced are likely to come. . . ." He is skeptical of the possibilities of planned research in the field of pure science and he emphasizes the importance of personal liberty for progress in scientific research. "The increase in efficiency of operation achieved by planning is balanced by the loss of independent thought, with the consequent diminution in the trial of ideas."

Dr. Mees closes on an optimistic note about the future of science and society. He believes that scientific method can and should be applied to the study of society; but he does not view scientific

method as a substitute for fundamental moral principles. He writes: "Truth and justice, mercy to the weak, and understanding for the erring are principles that require no formal justification. These are not the principles of science; they relate to spiritual rather than natural laws."

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AERE PERENNIUS

Banting's Miracle. Seale Harris. xx+245 pp. Illus. $3.00. Lippincott. Philadelphia. 1946.

SO MANY hearsay stories have been circulated about Banting since his discovery of insulin that the present volume based on accurate historic researches of the author is not only timely but highly appreciated by the medical historian and those who have ever treated diabetics. Although Dr. Harris collected the material for this biography in Canada, as his numerous acknowledgments indicate, he also states frankly and to his credit that he "was obligated most of all to Frances Williams Browin, one of Lippincott's editors, for revising and rewriting the entire manuscript which she transformed into a carefully arranged, chronologic biography."

It appears to this reviewer that Banting lived on the whole an unhappy, embittered, and frustrated life except when at short intervals after his international honors he betook himself with oil and brushes to scenic spots in Canada which he tried, with some tutelage, to record on canvas. He seems also to have suffered great disappointment in that he failed to add to his fame by a second Nobel prize-winning discovery—a goal most difficult to attain.

Naturally the author of this biography did his utmost to glamorize his Canadian hero, and properly so. But some of us who knew Dr. J. J. R. Macleod as a very personable and delightful scientist and gentleman are inclined to question, in part at least, the very despicable light in which Dr. Macleod is portrayed, since he is rather definitely accused as a scientist who attempted to filch *in toto* the monumental medical discovery of Banting, Best, and Collip. This is difficult for some of us to believe.

In one instance, which could be checked (p. 169), the author is partly unfair with respect to Macleod's article in the *Encyclopaedia Britannica* on insulin when he writes "that anyone reading that definitive article would never have dreamed that two men named Banting and Best were generally recognized as insulin's discoverers," since the article states in part: "In 1921, however, Banting and Best working under the direction of J. J. R. Macleod [sic!] found that extracts of partially degenerated pancreas contained the hormone." However, in the appended bibliographical references to the article, Macleod does not list any articles of Banting and Best, which surely is a serious and discreditable reflection on Dr. Macleod. As a matter of scientific accuracy, it should be pointed out that the author-clinician is not aware of the fact that depancreatized dogs may live more than a month without insulin, a fact which every laboratory man knows who has had any experience in this type of laboratory research. But this minor criticism is not sufficiently important to keep the biological scientist and layman from reading this intensely interesting and well-written book about a great, versatile medical hero and his trials and tribulations, one who was snatched from life by an airplane accident just when he was about to lead the tranquil and satisfying home life for which he longed so much.

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THEORY AND PRACTICE

What Industry Owes to Chemical Science. A Symposium. viii + 372 pp. Illus. $5.00. Chemical Pub. Co. Brooklyn. 1946.

IN THIS collection of fifty-three short essays on modern (British) practice in various industries, there are many specific references to the work of chemists, but by and large the impact of chemistry on industry is obscured and not illustrated by the details which have been included. There are in the collection some essays of quality, such as those on metals, dyestuffs, rubber, and drugs, and, notably, that on heavy chemicals. But the vast majority of chemical research, which I regard as a fascinating and exciting story, is omitted, or glossed over, or simply told in an uninteresting manner. A hint of national pride which was expressed in the introduction ("....British men of science, often in the face of small encouragement, have played their part in industrial development") may have contributed to decreasing the validity and interest of some of the essays.

It seems a pity to discuss aluminum, for example, without recalling that its manufacture by Hall and by Héroult (neither of whom was mentioned in this connection) was made possible by Davy's fundamental work on electrochemistry. In the chapter on dyes, August Kekulé is briefly mentioned, but the structural theory of organic chemistry, for which Kekulé was largely responsible, is nowhere outlined. Yet it was this theory which permitted scientists to determine the arrangement of atoms in dyes and drugs, foodstuffs and vitamins, solvents and fibers; it is upon this theory that the successful syntheses in all these fields are based. In particular, although some plastics were invented on a semi-empirical basis, the vast modern development of the field has been the direct result of an extension of structural chemistry. The simple theory of polymerization was largely developed by Carouthers (who is not mentioned); his patent for nylon is a magnificent example of the application of theory to technology.

The exact way of preparing the wood for lead pencils has its place in human knowledge (in some technical encyclopedia); the essence of the structural theory of organic chemistry underlies much of chemical industry. It is because such fundamental principles are neglected for the minutiae of industrial practice that I find *What Industry Owes to Chemical Science*, in general, unrewarding. I must, however, admit that I do not know an ideal book on the subject; the best that I can suggest is Alexander Findlay's excellent history, *A Hundred Years of Chemistry.*

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NOT SO BAD AS IT SEEMS

The Gardener's Bug Book: 1,000 Insect Pests and Their Control. Cynthia Westcott. xvi+590 pp. Illus. $4.95. American Garden Guild and Doubleday. Garden City, N.Y. 1946.

IF YOU know the name of the bug, you will find it listed alphabetically, with the plants that it attacks and the methods of control. If you do *not* know the name of the bug, find your plant in the list, and if it is a pest of that plant it will probably be there, with remarks on the injuries it does and sometimes a prescription for a remedy.

Starting with a general discussion of insects, the damage they do, and also their value in industry as scavengers, as plant pollinators, and as predators on, or parasites of, other insects, Dr. Westcott gives clear instructions on how to make the garden unpleasant for the bugs and pleasant for the plants. A great variety of garden chemicals

are treated concisely, and mechanical methods of using these as sprays, dusts, or fumigants follow in another chapter.

Brief remarks on the natural history and classification of insects are followed by a list of a thousand or so species regarded as pests, each with short though ample directions on control. Besides an excellent listing of most of the insects injurious to flowers, vegetables, and trees of North America, there are notes on mammals,[1] centipedes and millipedes, mites, salamanders, toads, sow bugs, slugs, and snails, a list long enough to appall almost any gardener; but an optimistic chapter, entitled It's Not So Bad As It Seems, gives a little cheer. No one has all these plants to worry about, and hence not all the insects, and as they come at different seasons, they can be worried about a few at a time. The Plant Doctor's Calendar tells you when to do the worrying.

No one, except that kind of entomologist, will read about two dozen kinds of thrips or a hundred aphids, but this manual helps you to identify the one that is bothering you, and spray it.

A bibliography and a glossary help make this an unusually satisfactory book on the subject, and one which should be appreciated by any gardener. The discussions here and there are written in a sprightly manner and make good reading, though the book will be used mainly as a reference encyclopedia. There are thirty-eight colored plates, some of them showing different stages of insects and the damage they do, and more than a hundred line drawings of pests (some also of mechanical apparatus) —all helpful to the information-seeker.

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[1] The mole can be eradicated, a cat being one of the best exterminators, but trapping or gassing will work. Rats, because they cannot vomit, die from red squill.

ONE MAN IN HIS TIME

The World Expands. George Howard Parker. vii + 252 pp. $4.00. Harvard Univ. Press. Cambridge. 1946.

Professor Parker well knows that much can be learned by a careful examination of the complete life cycle of a single animal, facts that are common to the species and facts that are peculiar to the individual. Moreover, much is to be inferred concerning the environment. When a particularly excellent specimen of a species that is fast receding elects to dissect himself and does so in excellent English prose, the product is an elegant contribution.

The World Expands is the autobiography of George Howard Parker, distinguished student and Emeritus Professor of Zoology, Harvard University. The first four decades of the current century of American zoology were marked by the leadership of a remarkable group of men, Parker, Wheeler, Harrison, Coe, Wilson, Morgan, Calkins, and later Woodruff, Conklin, Davenport, Jennings, Mast, McClung, F. R. and R. S. Lillie, Child, Wilder, Donaldson, and others. Most were American-born, all were able, energetic, and driven to prodigious effort by the tremendous challenge of the expanding fruits of experimental analyses. Among this group, the like of which may not be seen again, Parker is outstanding. Parker is then contemporaneous with the rise of experimental zoology. Lacking present-day instrumentation and awaiting a more adequate chemistry, experimental results were largely descriptive; mechanistic interpretations required shrewd analyses or were deferred. The reviewer well remembers a seminar with Professor F. R. Lillie in which occasionally the experimental findings seemed to admit of no rational explanations. When such situations arose Professor Lillie took prompt evasive action and ascribed the results to

"a property of the colloid matrix." Parker was a tireless investigator throughout this period and published prolifically. Unfortunately, his book treats of his many and varied researches sparingly.

Professor Parker and his contemporaries had much in common. Most of them struggled with personal finances when they were students and most of them studied or traveled in Europe. They took their work seriously, gave it dignity and substance, and created an important branch of learning in America. Unfortunately, on occasion they took themselves too seriously and from time to time the scene was enlivened by small war. In effect, Parker's autobiography is an account of the development of the intellectucal and personal life of one of these American zoologists who attained eminence. It is detailed, clear, and, since he follows the advice of Albert Campion that in preparing an autobiography one should "not allow any damned modesty to creep in to spoil the story," it is complete. There are the usual financial problem and its solution, the European study period with its exciting new scenery and old ruins, including a handshake with the skeleton of Johann Sebastian Bach, the contacts and friendships formed with European leaders, Leuckart, Lang, Wiedersheim, Lancaster, and others, all told in a style so engaging as to command interest in a reviewer to whom many of the names are no longer persons but landmarks in the development of modern biology.

Europe, especially Germany and Italy, and, later, Japan were visited before the seeds of self-destruction bore visible fruits in those now unhappy lands. Korea, China, Hawaii, Alaska, and the West Coast of the United States, Yosemite, and the Grand Canyon are the subjects of pleasant personalized sketches. Harvard under Eliot and Lowell, Woods Hole, and Bermuda are the framework within which most of the story occurs. And here is the linkage in personal and humanized terms between today and the days of the Agassiz', Asa Gray, and other eminents both in America and abroad. It is, by the way, comforting to learn from this book that Harvard once was worried greatly over a deficit of sixteen thousand dollars.

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WISDOM IS THE PRINCIPAL THING

Science, Its Effect on Industry, Politics, War, Education, Religion, and Leadership. D. W. Hill. v + 114 pp. $2.75. Chemical Publ. Co. Brooklyn. 1946.

THIS book contains seven essays (The Scientific Outlook, Science and Industry, Science and Politics, Science and War, Science and Education, Science and Religion, Science and Leadership) on our progress and our failures in applying the scientific method to all the pressing problems facing man of today. The author is a man with experience in, and understanding of, the scientific method who has stepped down from the ivory tower, with clarity of vision and a wide grasp of man's past and present problems. These essays are a challenge, particularly to all men of science, to all educators, to all industrial and political leaders in all lands today. Not that all these people will at once agree with the author as to the primary significance of the scientific method as the guide to action in all phases of life. But Dr. Hill's facts and logic will challenge both our traditions and our complaisancies. To this reviewer the strongest chapters are the ones on Science and Education and Science and War; the weakest, the essay on Science and Religion. Dr. Hill insists that "there is no outstanding problem between nations that the method

of science could not solve at a hundredth of the cost of a major war." He insists that a thorough training in, and a complete grasp of, the scientific method is a *must* in the education of every man and woman in every land. In the chapter on Science and Leadership the author appears somewhat off his *main course* in this one statement: "Scientists, in their writings, are too truthful and that makes them dull. In their modesty, they have no use for hyperbole" (p. 101). For are not hyperbole and the scientific method incompatibles?

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THE PEOPLE

The Navaho. Clyde Kluckhohn and Dorothea Leighton. xx + 258 pp. Illus. $4.50. Harvard Univer. Press. Cambridge. 1946.

THIS account of the largest tribe of American Indians in the United States is the third of a series of monographs resulting from a joint project of the Committee on Human Development of The University of Chicago and the United States Office of Indian Affairs. The purpose of the total project is to present data which will suggest means for more intelligent administrative planning and implementation of policies by the Indian Service. To say that this book is the best general report on the Navaho yet published is no exaggeration, and this is no small praise indeed for a book about a people living in a region so publicized, so well travelled, so thoroughly investigated, and so much written about as the southwestern United States! The story of "The People," as the Navaho call themselves, is so told and analyzed that for the nonspecialist it is not merely another collection of Indian "lore," but it has "meaning for anyone who is interested in human beings."

The first brief chapter on the past of The People is a model of clarity and conciseness. That an understanding of the history of any people is necessary for comprehension of their view of life is trenchantly brought out by the remark that one can no more understand the Navaho without knowing about his captivity at Fort Sumner in the middle of the nineteenth century than he can "comprehend Southern attitudes without knowing of the Civil War." The second chapter on land and livelihood presents the problem of making a living, nearly half of which is dependent on livestock, in a crowded and overutilized land in which life is hazardous to begin with. Attempts to solve these problems by shifting the basis of economy are frustrated by the emotional value and prestige value of the Navaho's sheep. Survival, therefore, depends upon delicately adjusted and maintained social cooperation, and chapter three tells how this is achieved. Social organization is primarily along the lines of kinship. "The importance of his relatives to the Navaho can scarcely be exaggerated." Biological family, extended family, "outfit," and clan are the important units, for The People are just beginning to develop a tribal consciousness.

The section on The People and the world around them is the longest and in some ways the most important in the book. It is an unbiased and objective description of the nature and results of contact between the Navaho and traders, missionaries, government employees, and other white persons. Considerable space is devoted to education, with an account of the reform in the Indian school system since 1933 and numerous pertinent suggestions for further improvement. The history of the Navajo Council might be called an experiment in partial self-government, and the chapter closes with suggestions as to how a more truly representa-

tive and workable government might be achieved by and for The People.

Three chapters are devoted to the relation between The People and the supernatural, or what we would call Navaho "religious life," although they do not have a term for religion in their language since they do not think of it apart from the rest of their life as we do. Supernatural beings and powers, ghosts, folk tales and myths, taboos, rites and ceremonials, and the misuse of such techniques, or witchcraft, are described. The analysis of the economic and social advantages of the religious system, for even the belief in witchcraft affords certain positive benefits, is an illuminating summary of Professor Kluckhohn's masterly treatments of such subjects in his previous monographs on *Myth and Ritual* and *Navaho Witchcraft*.

The chapter, The Tongue of The People, with its ingenious cartoons, is one of a very few—if not the first—semipopular discussions of the compelling force a people's language has upon their thinking. A sore need of English-speaking folk for successful living in our "One World" is a greater realization that differences in basic assumptions and attitudes, real or apparent, are often conditioned by differences in language. Americans are peculiarly resistant to linguistic analysis. The remarks on dealing with interpreters should be of much practical value to field workers in any foreign language area.

Finally, the Navaho "philosophy of life" is summarized in terms of ethics, values, and unstated premises of thought. Reflective study of this chapter should go far toward helping anyone, even mere readers of the daily international news, to begin to see things as others see them. Mention should also be made of the twenty splendid photographs.

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GENUS HOMO

The Human Frontier. Roger J. Williams. vii + 314 pp. $3.00. Harcourt, Brace. New York. 1946.

IN THIS book a scientist distinguished in one field outlines the need for another—*humanics*, a science to solve the problems of human living. In successive chapters he shows how present sciences may contribute to the new science, and the problems it may attack. After examining the role of metabolism in character, the relation between the senses and social behavior, the physiological and endocrine basis for behavior, and the basic psychological traits and capacities, Professor Williams moves on to topics such as: man and society, tolerance, mental hygiene, religion, education, marriage, criminology, medical research, heredity, leadership, employment, and international relations.

Professor Williams' excursion from chemistry into humanics is not random or cursory; he has read widely in the psychological and social, as well as the physical and biological, sciences. In his opinion our major scientific task is the study of man. Until we know man as completely as we know other scientific material, we will be our own worst enemies. Only knowledge of man will set us free.

The two basic faults of modern science are:

1. The high degree of specialization which causes the physiologist to study one, the anatomist another, the psychologist another, and the biochemist still another aspect of the human being without viewing the whole. "Men are too complex to be adequately studied by any one type of scientist" (p. 169). The case for a more inclusive and general science is well stated.

2. Science considers man as though all men were alike and could be treated alike. The robot—the statistical man, or "Mr. Average Man"—is the one about which

science generalizes. What is needed is knowledge of the individual—not of man in the abstract.

Here the criticism of present-day science is not on such firm ground. Not only are modern scientists quite as much interested in variability as in trends, but they are adding enormously to our understanding of the individual. Statistical techniques give increasing attention to the variability within populations, and many scientists are concerned with individual differences. Modern differential diagnosis using laboratory techniques in medicine or batteries of tests in guidance and placement make thorough explorations of the individual.

Professor Williams implies that many differences in personality and adjustment arise from differences in metabolism, or other physiological functions. The accuracy of such statements, which are common nowadays, is difficult to determine. When metabolic functioning goes below a certain critical level, marked changes in adjustment occur. But above this floor it is difficult, indeed, to demonstrate relations between metabolic make-up and behavior. Many of the generalizations made on the basis of extreme deficiencies produced experimentally in animals have little bearing on the normal functioning of humans.

The proposed science of humanics is not a science in the strict sense so much as a form of engineering designed to apply the knowledge gained in fundamental sciences.

> This science of human beings (which has for its purpose improvement in social control) we may call humanics. Only by learning its basic truths, teaching them to our youth, and by extending greatly the boundaries of our knowledge can we cope with numerous social problems: education, marriage, health, employment, charlatanism in politics and elsewhere, crime, alcoholism, group bigotry (whose name is legion), and war (p. 5). Humanics, as it will develop, will fall into the category of an industry because labor and capital will be involved in the production of a special type of valuable service (p. 277). The purposes of humanics. . .are related to those of the scientific psychologist but still they differ fundamentally. The psychologist. . .as a thorough-going scientist, must have no special bias or purpose other than to find and understand the truth. Such an attitude is absolutely fundamental to progress and the type of study which we are advocating has everything to gain from a strong and well-developed psychology. But the humanicist, if we may call him such, has an ax to grind; he is interested in the type of psychology and other knowledge that can be *used* and *applied* to social betterment (p. 125).

Williams does not consider the alternative for coordinating the sciences which proved successful with the atomic bomb, namely, the formulation of a major problem and the organization of a team of scientists from different fields with funds and facilities to attack it. Here integration is achieved by mobilizing resources on a problem rather than by developing a new specialty.

The discussion is best in terms of the need for integration and cooperative effort; it is poorest in indicating the avenues and devices by means of which the results desired are to be achieved. We ought to do something as scientists about society, but what? Williams' answer is a new practical science. But this answer ignores the fact that the application of scientific knowledge, even within limited areas, depends not upon one but upon a large number of professions and vocations. How are these professions and the public to be educated? Wants must be created within the population and basic information made available in some degree to all. How is humanics to produce its effects on society? The chapter on education, to my mind, was the most unsatisfactory and incomplete one in the book.

Professor Williams implies that a new profession of human engineers must carry the load of humanics and take the responsibility for substantial reorganization of our living. If such reorganization covers every phase of living, it would involve

complete guidance of the individuals who make up society. One wonders how well human beings would accept such complete controls and what the implications of such controls would be in terms of the organization of the state. I thought immediately of Aldous Huxley's *Brave New World*, which it might be well for some of us who propose Utopias to reread occasionally.

The book is stimulating, especially if one views it as a survey of the possibilities of an applied social science made by a keen and intelligent observer who sees many deficiencies in our present approaches to human problems.

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NATURAL HISTORY

The Wolf in North American History. Stanley Paul Young. 149 pp. Illus. $3.50. Caxton Printers. Caldwell, Idaho. 1946.

THE wide and varied public that may be expected to be actively interested in Mr. Young's account of *The Wolf in North American History* includes hunters and trappers, fur dealers and wearers of furs, western stockmen and farmers, historians and economists, and, most directly of all, naturalists and conservationists. The book is essentially a condensation of the author's share of *The Wolves of North America*, by himself and Major E. A. Goldman, published by the American Wildlife Institute in 1944.

Mr. Young's vast knowledge of the techniques and practices of wolf destruction has involved him in the study of the whole natural history of wolves. That his conclusions should be quite opposed to the complete extermination of the wolf is of fundamental interest to the naturalist and the private citizen who may be paying the bills for wolf destruction without being either consulted or, if they protest in the wolf's behalf, heeded. Our best interests may well be at variance with those of the western livestock men who graze their stock on public lands and obtain the diversion of national funds for what they frankly promote in private as a campaign of extermination, whereas in public they euphemistically refer only to predator control.

There is a chapter on the quite distinct red wolf of eastern Texas and Louisiana; a chapter on the development of the steel wolf trap, and a history of the gray wolf—the timber wolf—in America. This is essentially the record of its progressive elimination from the settled parts of the United States and Canada. The role of the wolf in European and American legend supplies the source of much misinformation about wolves, and especially the background of the transmitted heritage of anthropomorphic superstitions regarding their "viciousness" and "malevolence." We are indebted to the author for making accessible some of the notable American wolf stories of colonial times, especially the story of Israel Putnam and a renegade wolf of Connecticut, dating from 1739.

Mr. Young has been so closely identified with the "predator control" program of the Bureau of Biological Survey, and his book includes so little about the protests of naturalists against that program, and so little about the examples of major calamities to wild game, to natural vegetation, and ultimately to soils, resulting from the destruction of predators, that even his evidently sincere bow to preservation of the remnants of the North American wolf populations comes late and seems somewhat like a lack of knowledge on the part of the right hand of the left hand's efforts. Many naturalists regretted, and sometimes protested against, the transformation of the Biological Survey from

a government agency engaged in the investigations in field biology that laid a foundation for further ecological study of our continent into a corps of animal destroyers. The reviewer shares this regret but, like other naturalists, agrees that the gray wolf must be exterminated in settled areas. Mr. Young's testimony that the wolf need *not* be exterminated in wilderness areas will greatly strengthen our position. His book will remain a most interesting account of one of the most characteristic predators of the Northern Hemisphere.

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THE GOOD SOCIETY

Science and Freedom. Lyman Bryson. xi + 191 pp. $2.75. Columbia Univ. Press. New York. 1947.

THE scientific method should be applied to social science as well as to the physical and biological sciences. This suggestion, as well as the contrary one that social science is not a science and that the scientific method is inapplicable have been frequently heard. For those who would consider this question with care (and what more important business do we have these days than a better understanding, if possible, of the science of human relationships!), this profound and provocative book by Lyman Bryson, Professor of Education at Teachers College, Columbia University, and Counselor on Public Affairs to the Columbia Broadcasting System, is strongly recommended.

The title of the book does not at first suggest a study of how our present society can evolve toward a "good society." It is nevertheless an appropriate title, for the two terms, as defined in the first two chapters and used with univocal precision, are the basis for his thesis: that the way of working which has led us to our present state of understanding, or mastery, of the world of nature aside from man, at least deserves an earnest trial in seeking to understand, and master, ourselves.

Freedom is assumed to be an example of a "good," and then Mr. Bryson devotes his first chapter to describing precisely how he is using the term. His definition emphasizes variety of choice and variety of normalities. "A society or social group that treats with the same, or nearly the same, friendliness a wide range of behavior patterns is providing freedom in some real degree for its members." His concept of "economic democracy" and, later in the book, his description of three stages in the evolution of a free society are pertinent to much of the discussion these days about "democracy" and "free enterprise."

The chapter on What is Science? uses less space in defining science than it does in enlarging upon and clarifying the thesis of the book. For example, he deals quickly with those who object to scientific statements about human behavior because of the necessity for abstraction, by reminding them that the entities with which the physical and biological scientists deal in their advanced stages are always abstractions. The entity "triangle" as used by a mathematician is not subject to sensory observation. Thus, the "economic man" is also an ideal construct, defined arbitrarily for purposes of study.

Before suggesting what specific kinds of things a scientific humanist would do in working toward the good society, Mr. Bryson occupies himself with further prolegomena to clarify his concept of how social change occurs (peacefully where diversity is permissible; i.e., in a free society), the meaning of culture, the "person" as an entity of social science, the institution as a "set of habits shared by two or more persons in complementary relations . . . ," and the somewhat frightening term, "the social engineer." In his chapter on Education, however, it is

made clear that the social engineer would seek by all means at his disposal to "build in as many persons as possible, in the 'normal' person, the habits of free action . . . [and] loyalties to the institutions of freedom." (He is careful not to make the common mistake of insisting that men be free to do prescribed things and of being more concerned about the content rather than the conditions of freedom.) There is also a challenging discussion of the old problem of relating knowledge to action in this chapter on education.

For an evaluation of his brief nod to a "philosophic basis" for his argument, this reviewer refers you to the philosophers. His description, however, of three "patterns in the mental content" as *practical*, *absolute*, and *scientific* seems to me to be particularly helpful in understanding some of the basic controversies of modern life, and the slow emergence of the "scientific" pattern suggests a measure of cultural growth toward a good society. His approach to the definition of this good society is essentially pragmatic, but of special interest.

Mr. Bryson writes with precision and compactness. The book is not easy reading, but instead deserves a second reading. His frequent use of well-chosen examples to make his points clear is especially helpful.

As one who is oppressed on every hand by emphasis on material values, it is deeply refreshing to read a book which from the outset is implicitly and explicitly concerned with human values. The entire concept of freedom, set forth as a good, is apparently derived from a democratic belief in the importance of individuals having opportunities for self-realization. He describes a democratic government as "one that has for its purpose the creation of such conditions as will best keep and develop the intrinsic powers of men."

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MANKIND IN A TEST TUBE

Human Destiny. Lecomte du Noüy. xxi + 289 pp. $3.50. Longmans, Green. New York. 1947.

THIS is a very stimulating, altogether worth-while, and extremely timely book, but I am afraid the publishers have done its author a disservice by announcing in their "blurb" that it "presents a brilliant new interpretation of evolution and expresses a startling theory of Man's place in the universe." Actually, it gathers together in highly commendable fashion the widely held concepts of emergent evolution that have been current at least since Bergson's day and focuses their philosophical implications upon the crisis faced by humanity at the present time. This involves, of course, the consideration of the relations between science and religion, as well as the challenge to educators and all who are concerned with the training of youth.

Portions of the book are marred by an unfortunate use of foreign idiom, and the author is certainly not well versed in the vocabulary of American geologists. I think he overplays the gaps in the known paleontological record and at times seems to base certain conclusions on the absence of knowledge rather than upon inferences from verifiable data. But these are merely minor flaws in an otherwise praiseworthy production, and his fundamental thesis is sweet music to my ears.

Dr. du Noüy is one of the foremost biophysicists of our time. For several years an associate member of the Rockefeller Institute and then head of the Biophysics Division of the Pasteur Institute, he was serving as a director of the École de Hautes Études at the Sorbonne when France was submerged beneath the Nazi flood. He and his American wife escaped to the United States in 1942 and are now living in California. His scientific

and philosophic attainments have brought him many honors, including an award from the Franklin Institute of Philadelphia and the Arnold Reymand Prize of the University of Lausanne.

From this background of experience and knowledge, Dr. du Noüy reaches the conclusion that the methods which have proved so effective in interpreting the inanimate world fail utterly to explain, or account for, the origin of life or even the appearance of the highly dissymmetrical molecules which seem to be required as the basis for living organisms. But once life appeared, the course of organic evolution appears to have direction.

> Everything always takes place as if a goal had to be attained, and as if this goal was the real reason, the inspiration of evolution. . . .The laws of evolution are teleological, whereas those of the transformation of each species simply tend toward a state of equilibrium with the surrounding medium.

Acceptance of this concept of "telefinalism" helps Dr. du Noüy to penetrate the otherwise "absolute mystery" of the appearance of moral and spiritual ideas. With the emergence of man, a new phase of evolution is made possible. "Evolution continues in our time, no longer on the physiological or anatomical plane but on the spiritual and moral plane." With "the birth of conscience," when man

> asked himself the question as to whether an act was "good" or whether another was "better," he acquired a liberty denied to the animals. . . .When this occurred, man took another leap and increased the gap which already separated him from the other primates; the new orientation of his evolution was clearly indicated. Henceforth, contrary to all the others, in order to evolve he must no longer obey Nature. He must criticize and control his desires which were previously the only Law.

I agree heartily with Dr. du Noüy "that no progress will be made unless the ultimate solution is sought in an extension of the concept of evolution to the whole of nature, including man and his intellectual and moral development." Indeed, I wrote an article many years ago entitled "The Evolution of the Soul." But there are implications in this book with which I cannot agree. The sentence quoted above, with its statement that man "must no longer obey Nature," his reference to the "intervention of an Idea, a Will, a supreme Intelligence," and the suggestion that intelligence "will in fact almost always be opposed to moral and spiritual development" indicate a philosophical dualism that I cannot accept. Instead, I interpret the observable facts of evolution, past and present, to mean the constant and continuing presence within nature of an administrative Intelligence operating in different ways on different "planes," but always and everywhere consistent with itself. And certainly it requires all the intelligence that men can muster to discover the goal of moral and spiritual development, or even the paths that might possibly lead us a little way toward that goal.

KIRTLEY F. MATHER

Department of Geology
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Comments and Criticisms

IN THE NEGATIVE

The article "In Accentuation of the Negative," by T. V. Smith, (SM, December 1946) certainly fulfills the promise of its title. My reaction to it was decidedly negative.

Dr. Smith is presumably attempting to establish a philosophical basis for the theory that "that government is best which governs least" (a magnificent generality which is certainly true in a very restricted sense, and utterly false in many others). That is my interpretation of his position after reading his article; but he is so deliberately abstract and "general" in his discussion that I cannot really be sure of what specific realities he is concerned about.

Interpreted naively, his "rules"—modifications of the so-called golden rule—are simple truisms. But we can be quite sure that Dr. Smith does not so interpret them. For us to know exactly what he does mean by these rules, however, it would be necessary for him to state a few specific examples of how he would apply them to the real affairs of the world. This he has not done. I believe he is somewhat furtively attempting to support a position with which I disagree very strongly. But since he does not openly define his position, I cannot attack his arguments directly.

As a professional philosopher, Dr. Smith ought to have learned that words are unreliable tools for the conveyance of meaning on the level of the abstract and general, and must be aided in their task by frequent reference to specific things: events, persons, places, dates—in short, "referents." But evidently he has not learned this. When he does use "examples," they are only remotely related to present reality. Either Dr. Smith is really dwelling in that "ivory tower" so often mentioned in connection with philosophers and scientists, and is thus unwilling to degrade himself by specific reference to mundane realities, or else he does not quite have the courage to make a bald statement of his position.

I have a complaint also concerning the author's pedantically obscure style, which I believe has no place in a scientific journal (although it lends itself very well to the technique of concealing one's exact meaning). It is difficult enough to understand complex subject material even when an effort has been made to achieve clarity of expression. Here, however, there seems to have been almost a deliberate attempt to employ phraseology which requires intense mental effort for interpretation. I believe this practice grows out of a belief that any thought which is expressed intricately is necessarily the product of a sophisticated mind. (I am here using "sophisticated" in its best sense, as an antonym of "naive.")

This attitude, I am convinced, has done as much as anything else to prejudice scientists as a class against philosophy and philosophers. This is the more regrettable because it is so unnecessary. I am convinced that any worth-while thinking (and philosophers have done a great deal of it) can be expressed understandably and accurately without resort to grandiose and unfathomable phraseology. I concur with A. N. Whitehead's condensed statement of the situation (quoted in E. T. Bell's *Men of Mathematics*, p. xxi): "It is a safe rule to apply that, when a mathematical or philosophical author writes with a misty profundity, he is talking nonsense."

L. V. Blake

Washington, D. C.

THE BIG TEN

It is not often that I find time to read a scientific periodical from cover to cover, but your recent issues have been good, and well worth serious study. As a member of the Association for the past 22 years, though never taking much active part, I have been an interested onlooker. Surely we cannot but advance as a science when we have at the head of affairs such men as Chas. F. Kettering. As he remarks, it is truly alarming when our Monthly only aggregates 15,000 copies monthly. I believe that one writer put his finger on a good point when he said there should be more writing for the average man: after all, the real test of an educated man is that he can use simple language; tongue twisters, whilst very impressive, are seldom understood even within the one single specialty.

I have been interested, too, in the discussion relative to the ten most influential books of science. A recent critic has said that Pasteur was greater than Jenner, and hence his writings, rather than Jenner's, should have been included amongst the

ten. As one, however, who has written to the medical press reporting at least one big smallpox epidemic, which vindicated vaccination, let me point out that Pasteur, great though he was, was not the first, as Jenner was, to prove that specific immunity to an infectious disease could be built up by artificial means. Roger Bacon, too, of course, was important not because he classified most existing knowledge, but because he took men's minds away from argument and senseless philosophic discussion which led nowhere, and directed them to study nature—the book of life. It was this which was the spirit of the Renaissance. Freud, too, may seem important to some, but not more so than Adler and Jung; and there are some who do not class their work as of any too great importance anyway. Let's keep national animosities out of our discussions, Mr. Editor, seek to become less caustic, and treat matters on their scientific merits as true scientists should.

ROBERT KERR DEWAR

Fort William
Ontario, Canada

IMPONDERABLES

Mr. Thomson King's suggestive paper prompts me to supplement it with the message that I sent to my colleagues and students at the University of Virginia who gave me a reception when I retired last September. This message follows:

The prophet and his disciples seek life and are religious and risible. The scientist and his students seek ponderable entities and are apprehensive, wearing but a very sad smile in the face of free atomic energy.

Today the scientists' rather than the prophets' aspiration prevails. Some biologists speak of the terms "living" and "life" as meaningless. Life to many biologists is but a by-product of protoplasm's activity—life being secreted by protoplasm in much the same manner as are enzymes secreted. These biologists look to the day when morphology and physiology will be reduced to terms of physics and chemistry. This is a worthy problem for scientists. Joseph Needham is justified in making the following statement, "The aim of ***Entwicklungsmechanik*** is thus the reduction of the phenomena to the smallest number of causal processes." Someday the problems of morphology and physiology will be solved in physical and chemical terms.

But the contemplation of life or biology as an intellectual discipline carries us beyond form and function. Biologists must recognize the *use* of form and function. This fact has been ignored or slurred over by most biologists. Even those biologists, the psychologists, who should deal most intimately with life, seek to reduce their phenomena to ponderable terms. They have said, for example, that sensation varies as the logarithm of the stimulus; but they must leave behind all mathematical terms when confronted by beauty, truth, goodness, and a mother's love for her child. These are values that men, through use of their protoplasmic machines, interpret into an otherwise meaningless, monotonous universe. In the presence of these values, "a modern psychologist might squirm at being confronted with the etymological meaning of his science. . . .At the risk of shocking some people, I should assert that Pascal, for example, or Shakespeare has not been surpassed as a genuine psychologist" (Albrecht-Carrié, René. 1946. "One Scientist to Another," *American Scientist*, **34,** 472). So likewise, we biologists should "squirm at being confronted with the etymological meaning" of biology.

In this, my final greeting, may I remind you that life carries us beyond the ponderable. There can be, therefore, no science of life. As scientists, we biologists have our problems of form and function. As biologists, however, we have the fact of ***life*** and the manner in which it *uses* form and function. Biologists, in overlooking this fact, remind me of Elizabeth Barrett Browning's lines: "Every common bush is afire with God [Life], but we [biologists] sit around and pick blackberries."

I assert that Jesus Christ has not been surpassed as a genuine biologist.

WILLIAM ALLISON KEPNER

Charlottesville, Va.

HOW ABOUT MIND?

The article "On Life as a Separate Entity" in your February 1947 issue, by Thomson King, impressed me deeply. I also read, with great interest, Carlson's "Science and the Supernatural," appearing in August 1944, and contributions by Anna Rosenberg and Arthur H. Compton in later issues.

Thomson King postulates: (*a*) that there are two fundamental entities, matter and energy, in the universe, and that all phenomena are due to these, separately or in combination; or, (*b*) that there are three fundamental entities: matter, energy, and life—and that all phenomena arise from them.

From experience and by experiment we know that matter and energy are fundamental; everything that exists is due to the activity of matter and energy; yet there must be something else to account for phenomena: let us suppose that it is life and examine the last assumption.

It is generally accepted that there was a time when no life existed on earth; the condition of the stars and of stellar space is believed to be inimical

to life, although it is quite possible that life does exist on some planets. Thus life can hardly be regarded as a fundamental entity, like matter and energy.

What else is there that matter and energy cannot account for? How about Mind? Is life the cause of mind, or is mind the cause of life as well as of matter and energy? If we admit the existence of a Universal Mind and concede that it is the cause or substance of mind in all living things, are we not on a more secure footing?

In the light of recent development in atomic physics it is high time that a better understanding of the nature of matter and energy should prevail. Atoms are not abstractions, but are forms of energy, possessing weight and mass; occupy space, vibrate, and are three-dimensional, consisting of particles finer than themselves, made up of electric charges, negatrons and positrons, which, in turn, are created by gravitational energy that pervades all space. Like little bullets they can be fired into atoms either to disrupt them or build them up into higher atomic weights.

The conclusion seems to me to be inescapable that mind is a form of energy which cannot be destroyed and in consequence exists and persists after the so-called death of the body.

Motion is the only thing that enters the brain from the outside world; mind absorbs this motion and becomes aware of it. This would seem to prove that mind is a form of energy and, if so, it is indestructible.

I am sure that a large percentage of your readers are profoundly interested in these basic problems and it is to be hoped that more informative articles along similar lines will be forthcoming in the not too distant future.

HARRY LA VERNE TWINING

The Scientific Forum
Los Angeles

CARBORUNDUM

In reading an article entitled "Early Chinese Jade," by A. G. Wenley, published in the November 1946 issue of THE SCIENTIFIC MONTHLY, I noticed the following sentence on page 343: "The whole process is extremely time consuming and requires great skill and patience, although in recent times the use of carborundum as an abrasive and also the diamond drill has to some extent hastened the process."

My reason for bringing this sentence to your attention is that *Carborundum* is the registered trade-mark of The Carborundum Company and is used by this company to indicate the source of its abrasive products. *Carborundum* is not the name of an abrasive material but is a trade-mark which we use on all of our abrasive products, including those made of flint, emery, garnet, silicon carbide, aluminum oxide, and diamond.

I realize that it is often easy to slip into the use of a trade-mark in place of the correct name of the product or material to which we are referring. I am therefore taking this opportunity to ask for your assistance in avoiding misuse of our trademark *Carborundum* in THE SCIENTIFIC MONTHLY. I would greatly appreciate your cooperation with us in this matter.

W. G. SOLEY

The Carborundum Company
Niagara Falls, N. Y.

TO WRITE OR NOT TO WRITE

In his article on "The Principles of Poor Writing" published in THE SCIENTIFIC MONTHLY for January 1947, Dr. Merrill failed to state the most important principle: *Have nothing important to write.*

HOWARD B. HOLROYD

Bucknell University

UNDISMAYED

"Henry Adams and the Repudiation of Science" (Charles I. Glicksberg, SM, January 1947) prompts comments upon the meaning of the universe. The essence of the article implies that if humans cannot understand all the laws of nature then quit trying and retreat to religion—comforting after failure.

Henry Adams' worries can be attributed to farsighted vision, seeing much of the known, unable to reach yet undiscovered laws but entirely overlooking the closest of all facts.

The first law of nature should express the number of possible laws or, in a crude expression, $\frac{dN}{N} = \frac{N}{\infty}$, two imaginary ratios where the infinitesimally small number of laws now known bear a ratio to the number that ever will be known as that number bears to infinity.

As a corollary, N must be a summation of discontinuities, such as Newtonian mechanics, mental processes, history, and other observations. Religions (plural to avoid any denominational selection) are merely a small factor in mental processes but unfortunately the present age has not yet discovered that there are many terms that cancel each other, leaving simple (?) philosophy as a result.

In summation, work with what we have, search for more, but do not waste eight pages trying to relate dN with ∞; the impossible is obvious.

A. W. CLEMENT

Galion, Ohio

The Brownstone Tower

THIS issue should make its appearance at a propitious time. The editor will have returned from a short vacation and, full of spring and new hope, will attend a meeting of the A.A.A.S. Publications Committee. This new committee is now responsible for the supervision of policy of the SM and of *Science*. Headed by Dr. K. F. Mather, the committee may be expected to guide, stimulate, and support the editors in any innovations that seem promising and feasible to them. It is heartening that capable officers of the Association are now taking an active part in the development of the two journals.

As the leader of a committee meeting, Dr. Mather probably has few equals. On February 23 I watched him conduct the organization meeting of the Inter-Society Committee on Science Foundation Legislation. His performance was a masterpiece of precision and firm but good-humored control. Standing before a roomful of representatives of many scientific societies, Dr. Mather guided the election of officers of the committee and obtained expressions of opinion on some of the controversial features of the pending Science Foundation bills. By the time he had turned over the chair to the newly elected chairman, President Edmund Day, of Cornell, he had won the admiration of the whole audience. (For a report of this meeting and of developments in Science Foundation legislation in Congress read recent and current issues of *Science*.)

For the sake of economy in the face of rising costs all issues of the SM since February have consisted of 96 pages between covers. The first 32 pages are of coated stock suitable for half tones; the last 64 pages are of book stock. Thus the cost of manufacture per page is reduced to a minimum. In the past the article chosen to lead each issue was always one that the editors regarded as particularly significant for one reason or another. Under the present arrangement, however, the leading article must be illustrated, and it may or may not be as good as some of the unillustrated articles that must follow it. We have noticed that the readers will find the best articles wherever they are placed in an issue.

Partly as a measure of economy and partly because wrapping paper is scarce, we have mailed the SM unwrapped since the beginning of this year. Although many national magazines have adopted this practice, we were fearful that numerous complaints of damage would be received. To date, however, with three issues delivered, only four complaints have come to my attention. My personal experience with unwrapped deliveries is good; however, if some readers find their copies are not as crisp as they were last year, we ask their forbearance. But if any copy is badly damaged in transit, we want to be informed.

Much credit is due to Mr. Christensen and Mrs. Keener for working out the present Spring Book Issue. Many plans are incubating in our office for new features. "*Der Mai ist gekommen; die Baüme schlagen aus. . . .*"

This paragraph is added as the May issue goes to press. The coming of spring has been saddened for us by the sudden death of Dr. W. L. Valentine, editor of *Science*, on April 5. Sharing my office with him, I was impressed by his executive ability. Guided by the opinions of readers, he made many innovations in *Science*. His editorial career was brilliant. *Vale* Val!

F. L. CAMPBELL